

FRONTISPIECE to the FIRST VOLUME.

THE

MECHANIC;

OR,

COMPENDIUM

OF

PRACTICAL INVENTIONS;

CONTAINING

TWO HUNDRED AND FIFTEEN ARTICLES.

SELECTED AND ORIGINAL,

Arranged under the following Heads:

I. MANUFACTURES AND TRADE,
II. PHILOSOPHICAL APPARATUS AND THE FINE ARTS,
III. RURAL AND DOMESTIC ECONOMY, AND MISCELLANIES

ILLUSTRATED BY

One Hundred and Eight Copperplate Engravings;

WITH A

COPIOUS ANALYTICAL INDEX.

BY JAMES SMITH,

AUTHOR OF "THE PANORAMA OF SCIENCE AND ART."

IN TWO VOLUMES.—VOL. I

SEVENTH EDITION.

LONDON:

PRINTED AT THE CAXTON PRESS, BY HENRY FISHER,
(Printer in Ordinary to his Majesty.)
Published at 38, Newgate-street; and Sold by all Booksellers.
1825.

PREFACE.

THE utility of a descriptive collection of Inventions scarcely appears to require the aid of explanation. To the general inquirer, it is interesting to know the extent which mechanical ingenuity has reached; and the practical man stands in need of the same information, not only to supersede endeavours after objects already attained, but to shew what is yet wanting, and to furnish himself with a fund of hints which may be conducive to further improvements.

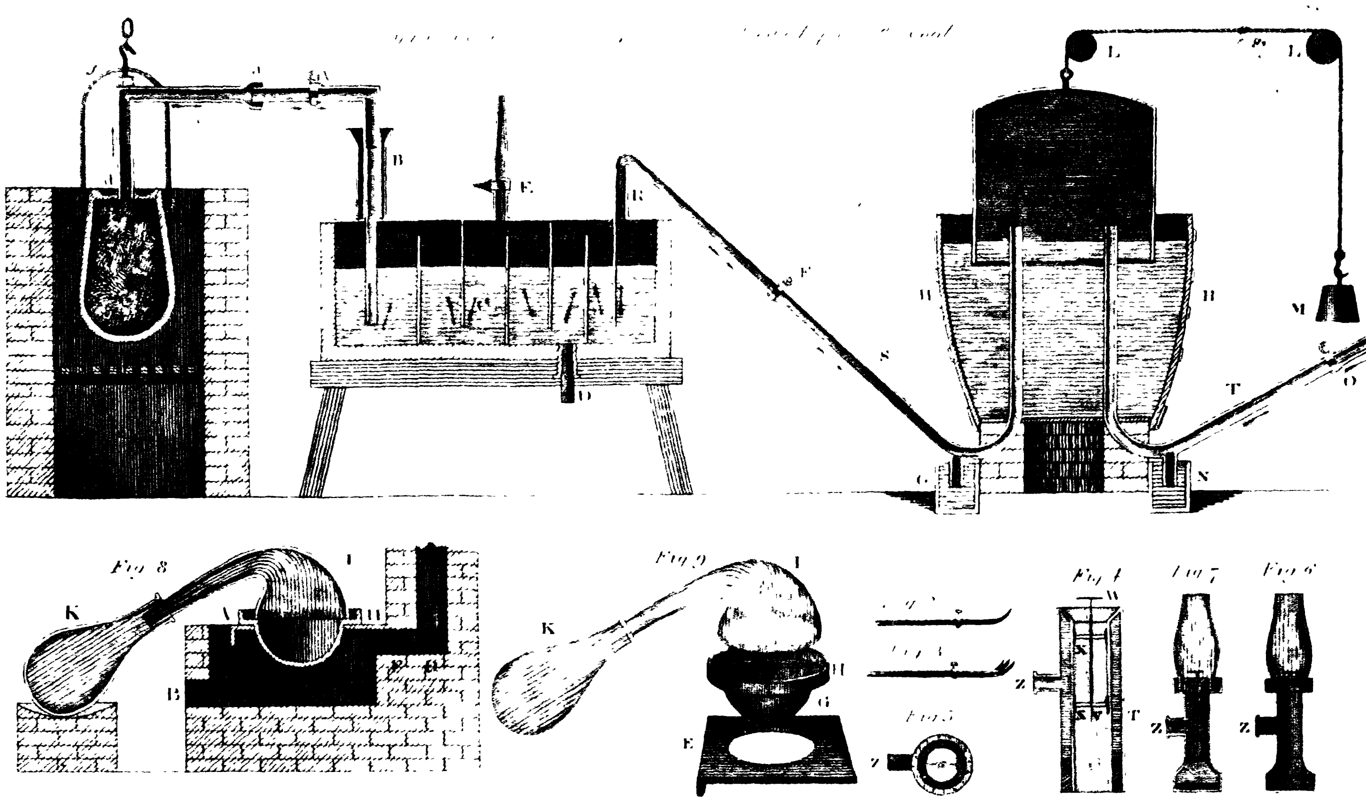
Descriptions of mechanical Inventions frequently contain valuable remarks, which admit of a general application to the Arts; and it is trusted, that the reader, with the assistance of the Index, will find no difficulty in discovering whatever may be contained in this work which bears upon the object of his research.

The alterations by which essays have been adapted to the plan of this work, could not with any precision have been pointed out: it has, therefore, been concluded, under the title of "A List of Inventions and their Authors," to give complete references to original sources of information, which, in cases where it may be desirable, will assist in determining the claims of particular individuals; at the same time that it records the names of those, whose ingenuity has contributed to benefit the community.

CONTENTS OF VOL. I.

Inventions relative to Manufactures and Trade.

[The figures at the commencement of each article, denote the Number of the Invention in the "List of Inventions and their Authors," given at page 421, Vol. II.]


B
E
R
F
S
H
H
L
L
M
T
O
G
N
D
Fig 8
K
I
A
B
Fig 9
K
I
H
G
E
Z
W
X
T
Z
Z
Fig 6

THE MECHANIC;

OR,

COMPENDIUM OF PRACTICAL INVENTIONS.

CLASS I.—RELATIVE TO MANUFACTURES AND TRADE.

Method of obtaining Gas for Light, and other useful Articles, from Pit Coal.

AMONG the various applications of chemical discoveries to the purposes of trade and common life, perhaps none has received a higher share of public admiration, than what are called Gas Lights. In the workshops of some of the most extensive manufactories in the kingdom, the use of candles and oil lamps has been entirely superseded by the burning of the gas obtained in the distillation of pit-coal, at an expense comparatively insignificant. Various forms of the apparatus requisite for this kind of distillation, have been adopted by different persons, and are distinguished by a great diversity of value;—some of them are costly, and others inconvenient; one possessing real merit, was invented by S. Clegg, of Manchester; it is described in the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, for 1808, and a silver medal was given to the Inventor: but the following communication, by B. Cooke, of Birmingham, to the same Society, in 1811, exhibits the art in a still more improved state, and exhibits the value of all the products of the operation in a new and interesting point of view. The ingenious author was also rewarded by the Society with a silver medal. He states, that having paid much attention to the procuring of gas, and other products, from pit-coal, he now lays before them the results of his experiments. The quantity of clear tar, which may be produced from every hundred weight of coal, is about four pounds, from which a liquor, or volatile oil, may

be distilled, which answers the purposes of oil of turpentine in japanning. Every gallon of tar will produce nearly two quarts of this oil by distillation, and a residuum will be left, nearly, if not quite equal to the best asphaltum. He sent to the Society a waiter, or hand-board, japanned with varnish from this residuum, and the volatile oil above mentioned. Tar spirit dries sooner, and will be found to answer as well as the best oil of turpentine, a circumstance which may be rendered of immense advantage to this country, as in the vicinity of Birmingham only, nearly ten thousand tons of pit-coal are coked or charred per week, and all the tar has hitherto been lost; but by his process, the coal-works of this kingdom might produce sufficient tar and pitch for the supply of all our dock-yards, boat-builders, and other trades, besides furnishing a substitute for all the oil of turpentine and asphaltum used in the country, and improving the coke so as to make iron with less charcoal.

Tar spirit may be sold at 8s. per gallon; varnish made with it not only dries sooner than that made with spirits of turpentine, but polishes more smoothly under hand, and takes a better gloss. These advantages were certified to the Society by J. S. Le Resch, japanner, of Birmingham. The following is a description of the apparatus for obtaining the products in question:

A, fig. 1, pl. I, is a common fire-place, a stove built with brick, having cast-iron bars to put the fire in at, and a flue that goes into the chimney. A is the cast iron pot, (which holds from twenty-five pounds to one hundred pounds of coal, according to the size of the premises to be lighted;) it hangs by the bewels or ears on the hook, suspended by a chain in this stove or furnace, and is about three inches above the bars of the grate, and three inches distant from the sides of the stove; the fire then flames all round this pot, and as it does not rest on the burning fuel, it is the flame only that heats it, so that it does not scale, but will last for years. The smoke, &c. is carried off by a chimney. The cover, *d*, of the pot is made rather conical, to fit into the top of the pot close, and from the top of the cover the elbow-pipe proceeds as far as the part *a*. The other end of the pipe, with the elbow entering the water-joint, is riveted to it after. When the lid or cover of the pot is put on, the bewels or ears come over the elbow of the pipe that is on the lid, and a wedge *f* is put between them and this elbow, to keep down the cover air-tight; and a little clay or loam may be applied as a lute to the joint, to prevent any gas from escaping round the cover of the pot. The

other elbow B goes into a water-joint, formed of a tube affixed to the cover of the purifier C, and another tube, which passes through the lid of the purifier: the elbow pipe then goes over the inner tube, and when put on, the jointing is made good by pouring water into the space between the tubes, which renders it air-tight. The gas, as the arrows show, passes down into the purifier C, which is rather more than half full of water; the use of this water-joint is for the convenience of removing the lid *d*, to which this pipe is attached. The purifier C is a wooden trough, with a sheet-iron top, to which the tubes are soldered, and it is fastened to the trough to keep all secure and air-tight. The sheets of iron, *e*, *f*, *g*, *h*, *i*, *k*, are alternately soldered to the iron top, and fastened to the wooden bottom. Now when the trough is half filled with water, the gas passes into it at B, and as it can only find its way out again at R, it must pass through the water. The inner pipe B, reaches under the surface of the water in the trough; so that when the gas is forced into the water, it would rise to the top of the purifier, and go along in a body to the end, and out at the pipe R, if the sheets of iron, *e*, *f*, *g*, *h*, *i*, and *k*, which stand across the trough with openings in them, alternatively at top and bottom, did not stop it, and hinder it going any way but through these apertures, purifying it all the time it is thus circuitously passing through the whole body of water, until it is properly washed; it then escapes through the pipe R, at the end of the trough C, and passing down the pipe S, is carried up into the reservoir or gazometer K. In the bottom of the purifier is an aperture, closed by a plug at D, to let off the ammoniacal water and tar as it is deposited; and the pipe, with the cock E, at the top of the purifier, is to burn away the spare gas when not to be used.

There is a stop-cock placed in the main pipe at F, that when the reservoir is full, and gas is making, and cannot be used, the cock may be turned, and prevent any gas from passing to the reservoir; and by opening the cock E on the top of the purifier, and firing it, all the gas which is made more than is wanted for use may be burnt away. If the cock F was not turned, the gas would continue to find its way into the reservoir K, which would overflow, and produce a disagreeable smell, easily prevented by this simple way of burning it as fast as it is made, when the quantity produced is in excess.

It may in some measure happen, that although the gas has passed through the purifier C, yet that a small portion of tar will pass along with it, and would either clog the pipe S, or accumulate in the reservoir. To avoid this, there is placed

at the bottom of the pipe S at G, before it rises into the reservoir, a jar, into which a pipe, made as shewn in the plate, conducts the tar; this collects all that passes through the purifier. It is filled with water, over which the gas passes up into the reservoir, but the tar drains down this lead pipe, and deposits itself in the jar of water. The longer the pipe S, the better, as it serves as a refrigeratory. H is a plain cask, made to any proper size, and filled with water, with a cock to draw off the water when it becomes foul. The upper vessel K is made of sheet-iron, riveted together in the manner engine-boilers are made. If it is only from five hundred to one thousand gallons in size, it will require only two cross iron bars at the top, and four ribs down the sides to keep it in form, with a strong ring at the top; and as there is no stress on this vessel, it will ascend and descend easily without any other support or framing, the plain sheet-iron sides being riveted to the four ribs, and it is quite open at the bottom. A strong rope runs over the pulleys LL, with a weight M to balance the vessel K, and assist it in rising and falling. The pipe J is that through which the gas passes from the reservoir or gazometer, and rising through the pipe T, is conveyed to all parts to be lighted. There is also another drain-pipe, at N; for after all the washing, &c. a very small portion of tar and moisture may rise into the pipes, and perhaps in time clog them, but by laying all the pipes in the first, second, and third stories on a small descent, if any tar or moisture should rise, it will drain down all the pipes from top to bottom, and be deposited in the earthen jar at N; by this means the pipes will not clog up in half a century. These jars must be sometimes removed and emptied, and fresh water put in, as also the water in the vessel H must be changed, to keep it clean and sweet; and the water in the purifier C should be changed every two or three days; by these means the gas will be deprived of all its smell, at least as far as washing will effect it, and the apparatus will be clean.

The stop-cock at O is for the use of a master, if he wishes to lock up the gas in the reservoir, to prevent his workmen, &c. wasting it in his absence; as also if any pipe should leak, or a cock be out of order, in any part of the premises, by turning this cock all the gas is kept in the reservoir while the pipe is repaired, or any other alteration made; it also extinguishes all the lights when turned, if any are left burning by careless workmen, nor can they be lighted until it is opened again.

The whole of this apparatus is simple, and not liable to get out of order in such a way, but that any person may put it right again. All the art required to make the gas, is to take off the cover of the pot, and without removing the pot to take out the coke, and fill it with fresh coal; wedge it down by putting an iron wedge between the bewels or ears, and the elbow of the vessel; and plaster a little clay or loam round the cover, to secure its being air-tight. A fire is then made under it, and the whole is done. The boy or man who does it, must now and then look at the fire and keep it up, until the pot is hot, and the gas comes over. In works where lights must be constantly in readiness, it is advisable to have two fire-places and two pots, so that when one pot is burned out, the other pot may be employed without the least delay. For this purpose the purifier must be provided with two of the water-joints B, one communicating with each pot, and the elbow pipe of each pot must have a stop-cock, as V: now when one pot is burning, the cock in the other pipe must be stopped, that the gas may not find its way out of the purifier; and when all the gas is extracted from that pot, the stop-cock V, leading from it, must be stopped, and the pot left to cool; while a fire is put under the other pot, its stop-cock is opened, and a supply of gas from it is passed into the reservoir; by these means one of the pots is constantly supplying the reservoir with gas, and the lights are always kept burning; one purifier is all that is necessary. The stop-cock V must be shut when either of the covers is taken up to fill the pot again with coal; when the elbow-pipe is lifted out of the water-joints, as the cover is attached to it, a plug may be provided to fit into the water-joint pipe, the moment the elbow is removed from it, or the gas will rush out of the pipe at the water-joint; but a better way would be, to lengthen the pipe of the water-joint B, and place a large cock under each of them, almost close to the top of the purifier; when one pot is burnt out, by turning the cock all the gas is kept in the purifier while the cover is removed, no plug being in this case necessary. For very particular purposes, as when dwelling-houses or counting-houses are to be lighted, and every vestige of smell destroyed, if simply washing the gas is not thought sufficient, to remove the little smell left (and very little indeed, if any, will be left) after the washing, a small trough may be added, made in the same way as the purifier, with sheets of iron across to force the gas through the pipe R, communicating with it. This trough may be filled with water, with a few lumps of lime put into it,

and this water and lime changed often; on the gas being forced through this lime-water, it will be still more completely deprived of any remaining smell; and, as has been before observed, by changing all the waters now and then, and keeping this small trough constantly supplied with clean water and lime, the gas, after passing it, will ascend the pipes to the lights in a state of great purity.

The gas obtained by thus distilling pit-coal, is called carburetted hydrogen. It burns with an intense white light, and should be allowed to issue from the burners by a very small aperture. The burners commonly used are merely slender tubes, inserted into the main pipes, and bent upwards a little at the extremity. They are furnished with a stop-cock, that they may be singly or individually extinguished, if necessary. Where but a small quantity of light is required they may be single, as in fig. 2; or with three or more branches, as in fig. 3. Still more splendid burners are those invented by S. Clegg, and described by him as follows, in the paper already alluded to: Fig. 4, shews the section of one of the gas lamps; the space between the outer tube T, and the inner tube V, receives the gas supplied by the pipe T, shewn in fig. 1, and a stop-cock is inserted for adjusting the flame; the gas passes through a number of small holes made in the outer edge of a circular plate, shewn at fig. 5, which unites the tubes T and V at their tops. V is the inner tube, which conveys the atmospheric air into the centre of the flame; the upper part of this tube is made conical, or widening outwards, to join the circular plate with holes in it, a horizontal view of which is shewn at fig. 5. W is a button, which can be placed at a small distance above the mouth of the lamp, and its use is to convey, in an expanded manner, all the air which rises through this tube to the inner surface of the flame, which materially assists the combustion; this button may be set at any convenient distance above the tubes of the lamp, as it slides in the cross bars XX, by which it is supported in the inner tube.

A current of air also passes between the glass tube or chimney and the outer tube T, through holes made in the bottom of the glass-holder, as in Argand's lamps; this surrounds the flame, and completes its combustion, as explained by the view, fig. 6, and section, fig. 7, which have a glass upon each. ZZZZ, figs. 4, 5, 6, 7, shews the tube through which the lamp is supplied with gas from the main pipe T, fig. 1.

It may be useful to observe, that cannel coal yields the

largest quantity of gas, and is usually employed where it can be obtained; that the gas made at a low temperature has been discovered to have a much stronger odour than that made at a high temperature; and that the gas which has stood over water for some days, is impaired in quality, and burns with a blue instead of a white flame.

In answering a letter from the Secretary of the Society for the Encouragement of Arts, &c. B. Cooke remarks, that he hopes in a short time to send an account of the establishment of a work that will be of such magnitude, as to supply that part of the country in which he resides, with the oil or spirit from the coal-tar, in sufficient quantity to supersede the use of spirit of turpentine, &c. in japanning; and hopes that in time works of the same description will be established throughout Staffordshire, whose products will supply the place of a great portion of the spirit used in the kingdom, while the pitch will be obtained in sufficient quantity to form a great part of that article now used in the dock-yards.

All that is wanted is the co-operation of the great coal companies and masters, to erect sufficient apparatus at the different works to preserve the tar at all the coke furnaces, and proper means to separate the spirit from the tar. It would be a great saving to the nation, as in every one hundred and twelve pounds of coal coked, there is lost by the present mode about four pounds of tar, and the cokes are not half so good as if they were coked in close vessels, to the exclusion of the atmospheric air. It would be superfluous to describe by drawings, the method of extracting the tar from pit-coal in close vessels, as it is so generally known; it must be clear to every one, that it is procured by distilling the coal, as when coal is distilled for gas only. The method of extracting the spirit from the tar, is the following, and the process is so simple that it will be immediately understood:

Fig. 8, is a section of the furnaces, and one of the retorts, almost any number of which may work in a line; the same flue will do for all, only taking care, if any are not at work, to stop up the draught-hole, which communicates with the flue. These furnaces are built without bars, grates, or doors. A is the place where the fuel is put in, to heat the retort G; the fire lies under it, and the smoke is carried off into the flue F. B is the aperture where the ashes are raked out. G is a section of the iron basin, or lower part of the retort; the dark shaded square part shews the space the fire occupies, and the black square D the flue as it runs along the back of all the line of

furnaces and enters the chimney R, as the arrow shews. I, figs 8 and 9, shews the upper part of the iron, earthen, or glass retort, fitted on the cast iron basin G. K, the receiver. By this mode of setting the retorts, all the great expense of bars, doors, frames, &c. is saved, and a brisker draught of air is obtained, which may be slackened at pleasure by covering up in part, or wholly, the fire-place A with a brick. E is a square iron plate with a circular hole in the centre, and is placed on the top of the furnace. The cast iron basin of the retort G, is made to the size of the hole in the plate: the most convenient size of the basin of the retort, is about five or six gallons, in the shape of a deep pot, with a flanch or rim H round the edge of it. This pot or basin of the retort is put into the iron plate E, and the flanch of the retort then rests on the plate E. I, is the upper part of the retort without a bottom, made to rest and fit on the flanch of the cast iron basin G. K is the receiver, larger in the mouth than the nose of the retort. To begin the work, fill, nearly, the iron basin of the retort G with coal-tar; then put on the upper-part of the retort I, and make it air-tight with a little sand thrown round it at the flanch H; the receiver K is put in its place, and a slow fire is put in at A, under the retort; the tar soon begins to simmer or boil slowly, and there then rises from it a thick whitish vapour, which fills the glass retort; part becomes condensed, and falls in drops from the sides of the retort into the tar again, while the purer spirit rising into the neck is condensed, and keeps dripping down the neck into the receiver; thas is the spirit of the tar, and that part of it which first rises, answers as well for varnish as when more highly rectified. The reason for having the receiver considerably wider at the mouth than the nose of the retort, is, that there is a strong and volatile oily ammonia, that does not soon condense, but gets out of the receiver into the air the instant it leaves the retort, and though but in a very small quantity, so small that it is hardly possible to catch it, yet will it impregnate the air for a great distance round with its very penetrating smell, while the spirit keeps dropping into the receiver pure and separate from the ammonia. The spirit of coal-tar thus obtained, is very volatile, quite as much so, if not more, than the spirit of turpentine, and evaporates in a short time if exposed to the air, which is a proof of its drying nature; indeed, when used as a substitute for spirit of turpentine, it dries in the stove, as before observed, quite as soon or sooner. Very little of the spirit is lost by repeatedly distilling in order to rectify it, if care is taken to have a slow

fire, and the process not hurried. When the spirit is perfectly extracted from the tar, there remains in the basin of the retort a beautiful pitch or asphaltum, which, when mixed with the spirit, forms an ingredient for making the black varnish used in japanning. If it is wished to use it as pitch, less spirit must not be extracted from it. Six gallons of tar will produce, if care be taken, about two gallons or two gallons and a half of spirit. A great number of retorts may be kept working by a single man; if we say only one hundred, and only worked down in a day, they will produce two hundred, or two hundred and fifty gallons of spirit in that time. When the spirit is used in the place of turpentine, the varnish-maker uses it in the same way, and in the same quantity, as there appears no manner of difference between it and spirit of turpentine in the making of varnish. When the asphaltum is used, it supplies the place of real asphaltum, and in about the same quantity.

Gas lights are daily becoming more general; and they have been found so great an acquisition to factories, foundries, and similar establishments, where strong and steady lights are required, that public companies have been formed in London, Liverpool, Preston, and other towns of consequence, to furnish the gas from pipes laid under-ground, for the use of shops, counting-houses, dwelling-houses, and even the public streets. For all these purposes, excepting the few cases in which fixed lights cannot be rendered available, gas lights are rapidly becoming general. The steady and clear whiteness of their flame is incomparably superior to that from oil, tallow, or any other combustible, and more favourable to the eyes than any other artificial light: at the same time it is perfectly cleanly, and yields so large a quantity of heat, as considerably to diminish the necessity for fires in the apartments where it is consumed.*

* Since the above essay was written, it has been found, that coal-tar may be almost wholly converted into carburetted hydrogen, by re-distilling it, or causing it to pass through a red-hot retort; that dry lime purifies the gas more completely than lime-water; that gazometers may be made of sheets of iron, let into a groove of wood at the corners, and prepared for use by caulking over; and that reservoirs for the gas may be made of varnished silk. It has also been found that several advantages result from the employment of oil, as the substance for yielding the gas for light; oil-gas contains so much more carbon in solution, that an equal bulk of it yields more than twice the light of coal-gas; it is also completely free from sulphur, with which coal-gas is mostly contaminated, it is rendered, with very little trouble in purifying it, almost free from smell, and the residuum in the retort is exceedingly trifling: to which it must be added, that the whole apparatus, required to make the gas from oil, may be so small, as to be admissible into an ordinary dwelling-house.

On Heating Rooms by Steam.

Steam has now been proved, by ample trial, to be a most valuable medium for affording an artificial temperature, not exceeding that of itself. It warms the air, without injuring it for breathing, like a stove; it is eminently economical for all large buildings, and the degree of the heat derived from it is susceptible of very exact regulation. With these advantages, it offers the additional one of perfect security against fire; for if the boiler in which the steam is produced is erected on the outside of the building to be benefited by it, the pipes conveying the steam may pass over, or even be surrounded by wood with impunity.

The proposed mode of heating rooms will, perhaps, be most distinctly explained by a brief history of its origin and progress.

In April, 1798, Neil Snodgrass was engaged by Macintosh and Dale, to manage a cotton-mill, near Dornoch, in Scotland; and he was led to consider of a cheap method of heating the mill, on account of the scarcity and dearness of fuel in the county of Sutherland, where the mill was situated. None of the methods which he had seen practised could be applied, but at an enormous expense, and his experience had pointed out to him important defects and inconveniences in them all. Having observed a mode of drying muslins, by wrapping them round hollow metal cylinders, filled with steam, practised at the bleach-fields near Glasgow, it occurred to him, that by means of a proper apparatus, steam might be applied to heat a cotton-mill, or any other large manufactory. It was evident that this not only would be an economical mode of producing heat in large works, so far as fuel was concerned, but that it would prevent the danger of fire, to which such works, when heated in the usual manner, are much exposed. He communicated his notions to a number of cotton-spinners and others, from whose suggestions he expected assistance; but he met only with discouragement, the project being every-where treated lightly, or pronounced to be impracticable. Strongly impressed, however, with the advantages of the plan, he persevered in his resolution to make trial of it, and ordered tin pipes to be made for the purpose. These were erected in the mill in May, 1799. When filled with steam, they at once produced the necessary degree of heat; but the pipes having been damaged in the carriage,

proved not sufficiently strong, and their position was unfavourable. With a view to some conveniences in point of room they had been carried up diagonally in one end of the mill, whence the upper sides of the pipes became sooner heated than the lower, which caused an unequal expansion. The water arising from the steam, condensed in the pipes in its return to the boiler, and also obstructed the steam in its ascent. In order to remedy these defects, the pipes were altered, and erected in a perpendicular position, and certain tubes were connected with them, to carry off the water arising from condensation. The whole apparatus, as it stood after this alteration, is represented by fig. 1, plate II.

This figure shews an inner gable, which is at one extremity of the preparation and spinning rooms of the mill. On the other side of this gable, there is a space of 17 feet, inclosed by an outer gable, and containing the water-wheel, the staircase, and small rooms for the accommodation of the work. In this space, the furnace and boiler are placed on the ground. The boiler cannot be shewn here, as it lies behind the gable exhibited; nor is it of any consequence, as there is nothing peculiar in it; it may be of any convenient form. The feeding apparatus, &c. are in every respect the same as in the boiler of a common steam-engine. A circular copper boiler, two feet diameter, by two feet deep, containing 30 gallons of water, with a large copper head, as a reservoir for the steam, was found to answer in the present instance.

The steam is conveyed from the boiler through the gable, by the copper pipe B, into the tin plate-pipe CC. From C it passes into the centres of the perpendicular pipes EEE, by the small bent copper tubes DDD. The pipes EEE, are connected under the garret floor by the tubes *ff*, for the more easy circulation of the steam. The middle pipe E, is carried through the garret floor, and communicates with a lying pipe 36 feet in length (the end of which is seen at G) for heating the garret. At the farthere xtremity of the pipe G, there is a valve falling inwards, to prevent a vacuum being formed on the cooling of the apparatus; the consequence of which would be the crushing of the pipes by the pressure of the atmosphere. Similar valves, KK, are placed near the top of the perpendicular pipes EE; and from the middle one E, a small pipe passes through the roof, and is furnished with a valve at I, opening outwards, to suffer the air to escape while the pipes are filling with steam, or the steam itself to escape when the charge is too high.

The water condensed in the perpendicular pipes EEE, trickles down their sides into the three funnels LLL, the

necks of which may either pass through, or round the pipe C, into the copper tube MM, which also receives the water condensed in CC, by means of the short tubes NN. The pipe CC, is itself so much inclined as to cause the water to run along it to the tubes NN, and the pipe G in the garret has an inclination of 18 inches in its length, to bring the water condensed in it back to the middle pipe E. The tube MM, carries back the water through the gable to the boiler, which stands five feet lower than this tube. It is material to return the water to the boiler, as, being nearly at a boiling heat, a considerable expense of fuel is thereby saved.

The large pipes are ten inches in diameter, and are made of the second kind of tinned iron plates. The dimensions of the small tubes are seen by their comparative size in the plate, and perhaps they might be varied without inconvenience.

The apparatus erected as here described, has been found sufficiently strong, and has required no material repairs since the first alterations were made. The leading object in the instance under consideration being to save fuel; in order to derive as much heat as possible from a given quantity of fuel, the flue from the furnace, which heats the boiler, is conveyed into the common stone pipes placed in the gable. These are erected so as to prevent any danger of fire, in the manner shewn in the plate, fig. 2. The steam, with this auxiliary, communicates a heat of about 70° to the mill, the rooms of which are 50 feet long, 32½ feet wide, and 8½ feet high, except the lower story and garret; the former of which is 11, and the latter 7 feet high. The rooms warmed in this manner are much more wholesome and agreeable than those heated by the best-constructed stoves, being perfectly free from vapour or contaminated air, and the expense of fuel, for the same degree of heat, is reduced at least one-half.

There are obvious defects in the application of the principle as practised in the instance described above. Some of these were known at the time of the first construction of the apparatus, though they could not be remedied; and the first successful experiment has been detailed exactly as it took place.

From the pipes being all at one end of the house, the heat was unequally diffused, and a considerable time elapsed, after their being first heated, before it reached the other end of the rooms. But, as the mill had barely room enough for the spinning machinery, it was impossible to erect the pipes in any other situation, or to convey them along the room, so as

to produce a more equal distribution of heat. This, however, can be easily effected, when there are no obstacles, such as have been mentioned; for example, in a cotton-mill consisting of six stories, a lying pipe of cast-iron, 5 inches in diameter, was carried along the middle of the lower story, about two feet from the ceiling, with a small declivity to carry off the water. This pipe heated the story in which it was placed. Tin pipes, 7¼ inches diameter, communicating with this lying pipe, were carried up perpendicularly through all the floors to the top of the house, at the distance of seven feet from each other, and formed a line of heated columns in the middle of each room. The same general plan was followed in another mill, where several irregularities in the building required a little variation of the contrivances for diffusing the heat to every quarter. Some of the rooms had been added after the first erection of the mill, and were awkwardly connected with the main body of the building. Into these the steam was carried by lying pipes, slightly inclined, and communicating with the principal apparatus. The steam, it was found, might without the least difficulty be distributed in any direction.

In the former of the last mentioned mills, the perpendicular pipes were connected under the ceiling of the garret by a pipe 2¼ inches diameter, slightly inclined, the extremities of which passed through the walls of the house, and were provided with valves opening outwards. A connecting pipe, with similar valves, was placed under the ceiling of the third story. These were intended for the more easy circulation of the steam; but still it was found that the perpendicular pipes were filled with steam rather slowly. The steam, when first thrown in, passed up the perpendicular pipe nearest to the boiler, and, being specifically lighter than air, occupied the apparatus, compressing the air in the lower parts of the rest of the pipes. Thus the resistance of the air will, for a long time, prevent the pipes from being completly heated; but this difficulty is easily obviated by having a valve or valves opening outwards, at the lowest part of the apparatus, through which the air, when compressed by the steam, is suffered to escape. In the mill just mentioned, the lying cast-iron pipe in the first story is carried through the gables of the mill, and furnished with valves for the egress of the air. It is unnecessary to repeat, that the same valves serve for the discharge of the air in heating the apparatus, and of the stsam itself, when its expansive force becomes too great. In both mills, each of the perpendicular pipes is provided with a valve, to prevent a vacuum; and in the

second mill, the lying pipes for carrying the steam into the detached rooms, have each two valves, one opening inwards, and the other outwards.

When these results had been obtained, the mode of constructing the steam apparatus represented by fig. 2, was found to be a great improvement upon the original plan before described.

The furnace for the boiler is shewn at *a*. The flue of the furnace conveys the smoke into the cast-iron stove pipes, 1, 2, 3, 4. These pipes are placed in a space in the gable, entirely enclosed with brick, except at the small apertures, 5, 6, 7, 8. A current of air is admitted below at 9, and thrown into the rooms by those openings, after being heated by contact with the pipes. This part of the plan is adopted with a view to prevent, as much as possible, any of the heat, produced by the fuel used, from being thrown away. It may be omitted where any danger of fire is apprehended from it, and the smoke may be carried off in any way that is considered absolutely secure. The risk of danger, however, from a stove of this construction, is certainly very small. One of the greatest inconveniences of a common stove is, that the cockle or metal furnace is liable to crack from the intensity of the heat. By the continuity of the metal from the fire-place, an intense heat is also conducted along the pipes, which exposes them to the same accident. Here the smoke being previouly conveyed through a brick flue, can never communicate to the pipes a degree of heat sufficient to crack them. In like manner, the pipes having no communication with the rooms but by the small apertures, cannot come in contact with any combustible substance; and from being surrounded with air which is constantly changing, can impart only a very moderate degree of heat to the walls. The iron supporters of the pipes may be imbedded in some substance which is a bad conductor of heat, as furnace-ashes and lime, &c. The emission of heated air into the rooms may be regulated by valves. As the pipes are not exposed to cracking, there is no risk of their throwing smoke or vapour into the rooms.

The boiler, *b b*, is six feet long, three and a half broad, and three feet deep. As there is nothing peculiar in the feeding apparatus, it is omitted. The boiler may be placed in any convenient situation. Where a steam engine is used for other purposes, the steam may be taken from its boiler. The pipe, *c c*, conveys the steam from the boiler to the first perpendicular pipe, *d, d, d*. There is an expanding joint at *e*, stuffed

to make it steam-tight. The steam, ascending in the first pipe, *d, d, d,* enters the horizontal pipe, *f, f, f, f,* (which is slightly inclined,) expelling the air, which partly escapes by the valve *g,* and is partly forced into the other pipes. The valve *g* being considerably loaded, forces the accumulating steam down into the rest of the pipes *d, d, d.* The air in these pipes recedes before the steam, and is forced through the tubes *h, h, h, h,* into the pipe *m, m, m,* whence it escapes at the valve *i,* and the syphon *k.* The water condensed in the whole of the pipes, passes also through the tubes *h, h, h, h,* into the pipe *m, m, m,* which has such a declivity as to discharge the water at the syphon *k,* into the hot well *n,* whence it is pumped back into the boiler.

The whole of the pipes are of cast iron, except *m, m, m,* which is of copper. The perpendicular pipes serve as pillars for supporting the beams of the house, by means of the projecting pieces *o, o, o,* which may be raised or lowered at pleasure by the wedges *p, p, p.* The pipes are sunk in the beams about an inch, and are made fast to them by the iron straps *q, q.* Those in the lower story rest on the stones *s, s, s, s,* and are made tight at the junction with stuffing. The pipe in each story supports the one in the story above by a stuffed joint, as shewn at *r.* The pipes in the lowest story are seven inches in diameter; those in the highest six inches; those in the other two are of intermediate diameters. The thickness of the metal is $\frac{3}{8}$ths of an inch. The lower pipes are made larger than the upper, in order to expose a greater heated surface in the lower rooms, because the steam being thrown from above into all the pipes, except the first, would otherwise become incapable of imparting an equal heat as it descends.

There is no necessity for valves opening inwards in this apparatus, the pipes being strong enough to resist the pressure of the atmosphere.

The cotton-mill is 60 feet long, 33 wide, and four stories high, the upper being a garret story. In the plate, five parts out of nine in the length of the building are only shewn; the apparatus will heat the rooms to 85° in the coldest season. It is evident that, by increasing the size or the number of the pipes, and the supply of steam, any degree of heat up to 212° may be easily produced. It may even be carried beyond that point by an apparatus strong enough to compress the steam; this however, can seldom be wanted.

The preceding experiments established the reputation of

steam for heating apartments; and they will shew what may be expected from particular modifications of the apparatus; but fig. 3, exhibits the arrangements now most approved: 1 2, 3, 4, 5, 6, the floors of the different stories; *a*, the pipe from the boiler supplying the steam, it enters the vertical pipe *b b*, and in its progress fills the lying pipes *c*, *d*, *e*, *f*, *g*, *k*, out of which it drives the air they may contain at the valves *h*, *h*, *h*, *h*, *h*, *h*, opening outwards, where the steam itself will escape, when too abundant or powerful. The water which forms by the condensing of the steam in the pipe *k*, passes down the small pipe *i i* to the lying pipe *l m*; the water from *g* by another small pipe, is also conveyed into *l m*; the water condensed in the pipes *g*, *f*, *e*, *d*, and *c*, is in like manner conveyed by as many separate pipes into the lying pipe *l m*; these small pipes cannot be seen in the figure, as they lie behind the pipe *i i*, but the manner in which they enter the pipe *l m*, is shewn perspectively at S. At *o* the pipe *l m* receives the water trickling down the vertical pipe *b b*, and thence the united streams proceed to the boiler. The inclination of the pipes *c*, *d*, *e*, *f*, *g*, and *k*, towards their extremities *h*, *h*, *h*, *h*, *h*, *h*, may be about one foot in a hundred. The supply of steam to the pipe of any particular room, may be lessened or cut off by means of the handles at *c*, *d*, *e*, *f*, *g*, and *k*, respectively; each of these handles is connected with the axis of a circular disk, or plate of iron, which when at right angles to the axis of the pipe, nearly fills the bore, as at Q; but when parallel with the axis of the pipe, as at R, it only presents a thin edge to the steam, which has therefore a free passage on each side of it. The handles of all these valves should be so placed as in the same relative position to indicate the positions of the disks; the best position, when they are open, will be for them to hang-down vertically, and then the horizontal position obtained by one quarter of a turn will indicate the closure of the pipe. Thus is easily obtained the convenience of diminishing the quantity of steam let into any particular apartment.

Each of the lying pipes is furnished with a valve, *h*, *h*, *h*, *h*, *h*, *h*, in order that the apparatus may still be safe and complete, whatever number less than the whole of the pipes may be out of use. All the pipes are fastened together by flanches and screw bolts, as pipes thus united are more easily put up and taken down than by socket joints. The substance put between the flanches is thick pasteboord soaked with linseed oil. The small pipes by which the water is conveyed from the steam-pipes may be of lead or copper; the pipe *l m* has a

stuffed joint at *l*, to yield to any strain there may be upon it from the motion of any of the pipes in expanding and contracting.

The boiler B is constructed and set up like those of steam engines; *t* is the safety valve, which, when the steam is too powerful, is raised, and the superfluous steam passes off into the flue, by the pipe *x*. *y* is a reservoir of water, from which the pipe *r* enters the boiler; the pipe *r* terminates with a ball-cock, adjusted in such a manner that it is closed when the boiler is two-thirds filled with water, but is more or less open as the water declines from that height. *u* is a small rod, working through a stuffing-box, and acting upon the ball of the cock upon the pipe *r*, so as to depress it, and to let in, if thought proper, the supply of water more rapidly than would otherwise take place. The reservoir *y* is about 18 feet above the boiler, that the water from it may have sufficient pressure to overcome that of the steam in the boiler. *s* the barometer, to shew by inspection the strength of the steam, and consequently whether the fire is in excess or deficient. *w*, a pipe from the boiler, by which the water in the reservoir *y*, may be kept from freezing in winter. The water may be raised to the reservoir *y* by a forcing pump, or may be supplied in part by the rain-water from the roof of the building to which it is attached. If thought necessary, a float may be used, to shew from below the height of the water it contains.

A small tube, bent in the manner shewn at fig. 4, and called an inverted syphon, is frequently attached to steam-pipes instead of a valve *h*, and answers the same purpose. It should be long enough to contain, in its two vertical limbs, about nine or ten feet of water. The opening of this pipe should be on the outside of the building; but that part of it in which the water lodges should be within, or at least be protected from the cold, in order that the freezing of the water in it may not prevent its acting as a safety valve.

As dirt collects in iron pipes, by the separation of sand and rust, and is driven towards the lowest extremity of the lying pipes, where the small pipes are inserted to carry off the water, these small pipes should not have a less bore than one inch; the dirt which then enters them will collect at S, as in a reservoir, one end of which should only be screwed on, to admit of its being occasionally cleansed.

It has been found by experience, that rooms may be most effectually heated by steam, by observing the following rules:

1. The pipes to be cylinders of cast-iron, four inches in diameter and half an inch thick.

2. They should not deviate more from a horizontal position than what may be required to carry off the water of the steam that may condense in them.

. They should be laid in the direction of the length of the room to be heated, along the middle, and about eight inches above the floor at the lowest end.

4. They should not be wedged or fastened up, either at the ends or upon their supports; and at each end, for every twenty feet of their length, they should have a space of at least one inch, to admit the motion communicated to them by their expansion and contraction, as they heat and cool.

5. The water formed by condensation should be drawn off from each pipe separately, to prevent it from interrupting the ascending steam.

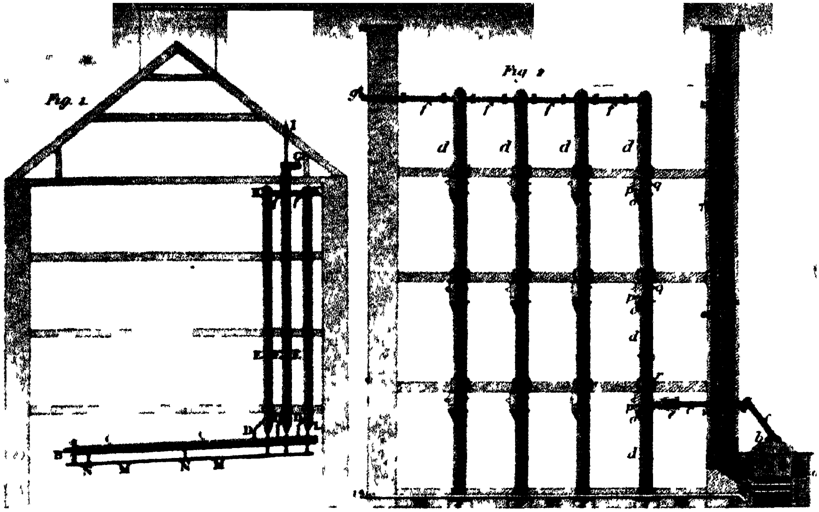
6. No two steam-pipes to be fastened together at both ends.

Of these directions, the one which it is generally the most inconvenient to observe, is that which relates to the distance of the pipes from the floor. If the pipes, however, for the sake of passing under them, must be six feet above the floor, to have them at that height will be better than to go higher. Vertical pipes have the most agreeable appearance, but they are much less effectual than horizontal pipes, from the constant tendency of heat to ascend; and whatever care may be taken, as in fig. 2, to supply them with stuffed joints, they should never be employed to support a floor, as their motion would tend to injure the building.

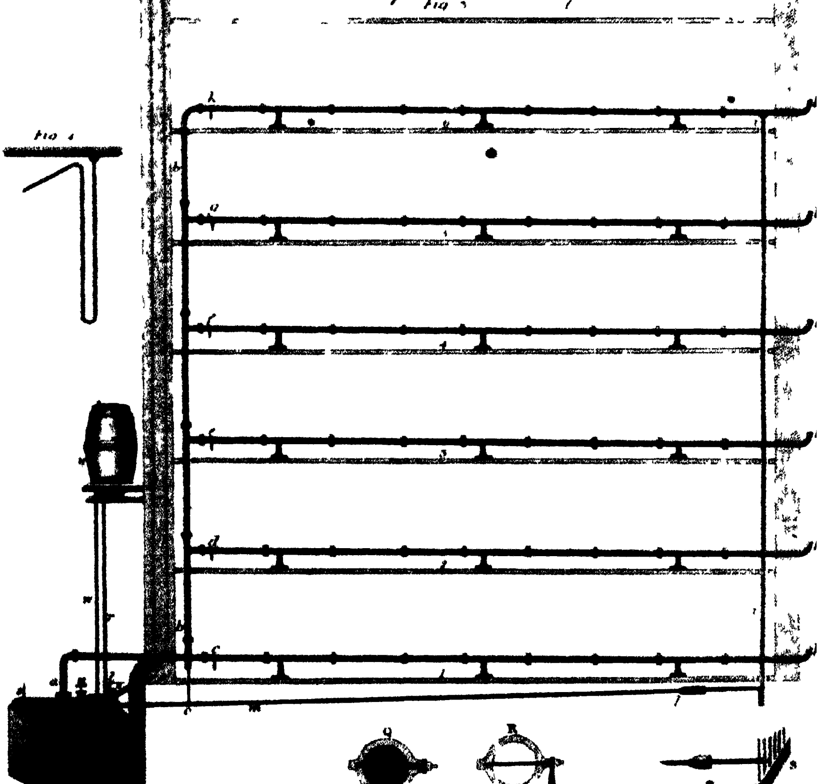
When the breadth of an apartment materially exceeds ten yards, it will diffuse the heat better to have two ranges of pipes, than to have a single pipe of larger dimensions than has been mentioned.

When the boiler is not placed below the first floor which is to be heated, the water from the pipe which heats that floor cannot be conveyed directly back to it, but it is of little consequence whether the steam enter the heating pipe from a little above or not.

The heat from steam is very successfully employed in drying malt, linen, paper, &c. and by dyers and others for boiling water, in the largest vessels they require; when the boiling is effected by steam, metallic vats are unnecessary, wooden vessels, or large stones cemented so as to hold water, answering the same end: when steam is employed for boiling water, it must always enter at, or very near the bottom of the vessel. Steam, strongly condensed in stone chambers, has even been found effectual in bleaching linen goods.



The heating of Rooms by Steam



Publish'd by Henry Fisher, Caxton, London 18[illegible]

Mill for grinding Colours.

The very unmechanical, inconvenient, and highly injurious method hitherto used for grinding noxious and poisonous colours, first led the Inventor of this machine to reflect on the contrivance of a better. It must be obvious to every person, that the method of grinding colours on a horizontal marble slab, with a small pebble muller, requires the body of the workman to bend over the slab; in consequence of this position, he inhales the noxious and poisonous volatile parts of the paint, which is not unfrequently ground with oil saturated with litharge of lead; and if we may judge from the very unhealthy appearance of the men accustomed to much colour-grinding, the bad effects of this employment call for a remedy.

The machine now proposed has not only to recommend it, the advantage of preventing this severe evil; but it grinds the colour more easily, finer, and quicker, than any method hitherto adopted. Having occasion for a large quantity of colours in the finest state possible, the Inventor has used the machine, for several years, with the greatest advantage. The roller of the machine he uses is sixteen inches and a half in diameter, and four inches and a half in breadth. The concave muller that it works against covers one-third of that roller: it is therefore evident, that seventy-seven square inches of the concave marble muller are in constant work on the paint, and the paint may be much oftener brought under this muller in a given time, than in the usual method with the pebble muller, which is seldom more than four inches in diameter, and consequently has seldom more than twelve square inches at work on the paint. Here the hand muller is stated at the largest, and the roller at the smallest size which it would be proper to use. A roller two feet or more in diameter, with a concave muller in proportion, would not be too hard for a man to turn, while the work performed would be greatly increased.

This machine will be found equally useful for the colours ground in water, as for those ground in oil. The great importance of so simple a contrivance, for the purpose in question, will, upon trial, be experienced in all manufactories where colours are used.

In plate III, fig. 1. A is the roller or cylinder, made of any kind of marble; black marble is esteemed the best, because it is the hardest, and takes the best polish.

B is the concave muller, covering one-third of the roller, and of the same kind of marble as the roller, and is fixed in a

wooden frame *b*, which is hung to the frame E, at *i i*. The roller and muller must be accurately formed to the same sphere.

C is a piece of iron, about an inch broad, to keep the muller steady, and is fixed to the frame with a joint at *f*. The small binding-screw, with the fly-nut, that passes through the centre of the iron plate at *c*, is for the purpose of laying more pressure upon the muller, if required, as well as to keep it steady.

D is a taker-off, made of a clock-spring, about half an inch broad, and fixed like a frame-saw in an iron frame K, in an inclined position to the roller, and turning on pivots at *d d*.

G is a slide-board to draw out occasionally to clean, &c. if any particles of paint should fall from the roller; on this slide-board is laid the plate H, to catch the colour as it falls from the taker-off.

F is a drawer, for the purpose of containing curriers' shavings, which form the best cleansers of paint-mills.

E is the frame.

Previous to the colour being applied to the mill, it should be finely pulverized in a mortar, covered in the manner of the chemists, when they levigate poisonous drugs; or by the use of a mill similar to those used for grinding indigo in a dry state. A description of an improved mill of this kind, is given in the following article. After this process of dry grinding, which is equally necessary for the marble slab now in use, the colour should be mixed with oil or water, and with a spatula or pallet-knife put on the roller, near the top of the concave muller, and the roller turned round, which takes the colour under the muller without any difficulty, and a very few turns of the roller spread it equally over its surface. When it is perceived sufficiently fine for the purpose required, it is very easily removed by holding the take-off, D, against the roller, and turning the roller the reverse way, which cleans it very quickly and very completely. The muller will only require to be cleaned when the workman desists, or the colour is to be changed; it may be turned back, as it is hung on hinges to the frame at *i i*, and it may be cleaned with a pallet-knife or spatula very conveniently. Afterwards a handful of curriers' shavings, held on the roller during two or three revolutions, cleans that part effectually.

The quantity ground at once on this mill, must be regulated by the state of fineness which the colour is required to possess; and the same remark applies with respect to the time required. It will suffice to observe in general, that with a machine of the size now described, a man may in three hours produce as great an effect as by a day's labour with a muller upon a marble slab, and the waste will be much less.

When the colour is ground, the Inventor recommends the following mode of tying it up in bladders, in preference to the common method. Instead of drawing the neck of the bladder close in the act of tying it, insert a slender cylindrical stick, and bind the bladder close round it. This when dry will form a tube or pipe, through which, when the stick is withdrawn, the colour may be squeezed as wanted, and the neck again closed by replacing the stick. This is not only a neater and much more cleanly mode than the usual one of perforating the bladder, and stopping the hole with a nail, or more commonly leaving it open, to the prejudice of the colour; but the bladder being uninjured, may be used repeatedly for fresh quantities of colour. The barrel of a quill may be substituted for the stick, with its closed end outwards, which will keep the colour secure in carriage: and the quill, after its closed end has been cut off, to take out the colour for use, may be stopped with a piece of stick.

When the roller of this mill is so small as sixteen inches or thereabouts in diameter, the use of a fly-wheel, on the extremity of the axle, by equalizing the power of the workman, would enable him to labour more pleasantly, and to perform a much greater quantity of work. When the stone is large, its weight will serve in lieu of a fly-wheel. If the particles of the colour be hard, the best mode of intimately combining them with the vehicle, is by a strong pressure, and a slow motion. It may also be observed, that a motion so rapid as to heat the roller would be apt to injure the brilliancy of delicate colours.

Where several of these mills are employed at once, they may be advantageously arranged as described in the article on Anderson's method of painting canvass &c. given in another part of this work.*

* Of the methods which have been proposed to carry off, during the common process of grinding paint, the noxious or poisonous effluvia, produced by mineral colours in particular, one of the best may be explained as follows: a cover, shaped like a funnel, is provided; it is as large as the marble slab, over which, with its mouth downwards, it is suspended, at such a distance that the workman can just conveniently use the muller. From the upper part of this cover proceeds a pipe, like the pipe of a stove, and terminating in the open air. At a suitable distance from the workman, the pipe is heated by a small fire; which constantly draws a current of air from the part beneath the cover, and with that current flies up the effluvia from the colour. The cover, from its conical shape, allows the workman to lean over the slab, though not with all the convenience which is desirable; and without repeating the remarks on the mechanical loss of grinding by hand, it is obvious that the hands and arms, which must be generally bare, may, from the effluvia and daubs they receive together, imbibe injurious matter, to which the use of the grinding machine would not expose the workman: but where the machine is constantly employed, and large quantities of colour ground, the cover and pipe above described, might be suspended over it, and the effluvia be thus completely carried out of the apartment; by

A Mill for grinding Indigo and other Dry Colours.

Plate III, fig, 2, L represents a mortar made of marble or hard stone; one made in the common way will answer.

M, a muller or grinder, nearly in the form of a pear, in the upper part of which an iron axis is firmly fixed, which axis, at the parts NN, turns in grooves or slits, cut in two pieces of oak projecting horizontally from a wall; and when at work, it is secured in the grooves by iron pins, OO.

P, the crank of the axis, by which the grinder is worked.

Q, the wall in which the oak pieces, NN, are fixed.

R, a weight, which may occasionally be added, if more power be wanted.

Fig. 3, shews the muller or grinder and its axis separately; its bottom should be made to fit the mortar.

S, a groove cut through the stone.

The muller being placed in the mortar, and secured in the oak pieces by the pins, the indigo is thrown above it into the mortar; on turning the handle of the axis, the indigo in lumps falls into the groove S, and is thence drawn under the action of the muller, and propelled to its outer edge within the mortar, whence the coarser particles again fall into the groove of the muller, and are again ground under it; which operation is continued, till the whole of it becomes an impalpable powder; the muller is then easily removed, and the colour taken out.

The groove S, should widen towards the bottom of the muller, that the lumps of indigo may more readily fall down.

A wooden cover, in two halves, with a hole for the axis, is usually placed upon the mortar during the operation, to prevent any loss to the colour, or bad effect to the operator.

In mills and manufactories, where water, steam, &c. is employed for moving the machinery, the indigo mill is seldom wrought by hand; but when it is wrought by hand, a horizontal fly-wheel might advantageously be used instead of the ball R, fig. 2, to prevent the loss of power, occasioned by the unequal action of the man upon the crank or handle P; but as a fly-wheel, in this position, presses with so much weight, it should not be very large; if made of iron, two feet diameter is a suitable size, with the transverse girth of the rim about four inches.

---

which means colour-grinding might be conducted to any extent with perfect safety to the most delicate constitution. And in the ordinary use of the machine, it will be proper, if there be any current of air through the apartment, for the workman to stand on the side from which it comes; or if there be a fire for the machine to stand between it and him.

On the Ventilation of Mines, Hospitals, &c.

Next in importance to the means employed for draining underground works from water, may be reckoned those which are intended to afford a supply of pure air, sufficient to enable the workmen to continue their operations with ease and safety to themselves, and to keep up undiminished, the artificial light upon which they depend. It is well known, indeed, to all who are practically engaged in concerns of this kind, that men are frequently obliged to persevere in their labour where a candle will scarcely burn, and where not only their own health materially suffers, but their employers are put to considerable expense, by the unavoidable hinderance, and the waste of candles and other materials.

The following remarks will be confined to such mines as are worked upon metalliferous veins, according to the practice of this district, (Holwell,) and that of the great seat of mining in the neighbouring county of Cornwall. It is found that a single shaft, not communicating by levels to another, can hardly be sunk to any considerable depth, nor can a level (or, as the foreign miners call it, a gallery) be driven horizontally to any great distance, without some contrivance being had recourse to for procuring currents of air to make up the deficiency of oxygen, which is so rapidly consumed by respiration and combustion in situations like these, where otherwise the whole remains nearly in a stagnant condition.

They are here unacquainted with the rapid production of those gases which occasionally, in the collieries, are the cause of such dreadful effects: such as hydrogen gas or the fire-damp, carbonic acid or the choke damp; the inconvenience they experience takes place gradually as they recede from the openings to the atmosphere, and seems to arise solely from the causes before assigned, though it is found to come on more rapidly in certain situations than others.

The most obvious remedy, and that which is most frequently resorted to, is the opening of a communication either to some other part of the mine or to the surface itself; and as soon as this is done the ventilation is found to be complete, by the currents which immediately take place, often with considerable force, from the different degrees of temperature in the subterranean and upper atmospheres; and these currents may be observed to change their directions as the temperatures alternate.

The great objection to this mode of curing the evil, is the enormous expense with which it most commonly attended. In driving a long level or tunnel, for instance, it may happen to be at a great depth under the surface, and the intervening rock of

great hardness; in such a case, every shaft which may be sunk upon it for air alone, would cost several hundred pounds; or in sinking a shaft, it may be necessary, at an expense not much less, to drive a level to it from some other, for this purpose alone.

To avoid this, recourse has been had to dividing the shaft or level into two distinct parts, communicating near the part intended to be ventilated, so that a current may be produced in opposite directions on each side the partition; and this, where room is to be spared for it, is often effectual to a great extent. It is found, however, to have its limits at no very great distance, and the current at best is but a feeble one, from the nearly equal states of heat in the air on each side. Another scheme is, to force down a volume of pure air, through a system of pipes placed for the purpose, and a variety of contrivances have been devised for effecting this; most of them are so old, that they may be found described in Agricola's works *De re Metallicâ*. The most common are by bellows worked by hand; by boxes or cylinders of various forms placed on the surface, with a large opening against the wind, and a smaller one communicating with the air-pipes by a cylinder and piston working in it, which when driven by a sufficient force, has great power; but the cheapest and most effectual mode of proceeding upon this plan, where circumstances will admit of its being applied, was adopted in the ventilation of the tunnel of the Tavistock canal. It is by applying the fall of a stream of water for this purpose; and it has been long known that a blast of considerable strength may be obtained in this manner, which has the advantage of being constant and self-acting. The stream being turned down a perpendicular column of pipes, and dashing in at a vessel so contrived as to let off the water one way, with an opening at another part for the air, which being pressed into it by the falling water, may be conveyed in any direction, and will pass through air-pipes with a strong current, which will be found efficacious in ventilating mines in many instances, as it has in some cases been sufficient for urging the intensity of fires for the purposes of the forge. It is easily procured, where a sufficient fall is to be had, and the perpendicular column can be so fixed as that the water from the bottom may pass off, while the air is forced into a pipe branching from the air-vessel, and which is to be continued to the part of the mine where the supply of fresh air is required.

But the forcing into vitiated air, a mixture of that which is purer, even where the best means are used, though a measure which affords relief, is not, in bad cases, a complete remedy, and where the operation depends on manual labour, or any means that are not unremitted in their action, it becomes

quite ineffectual. The foul air, charged with the smoke of gunpowder used in blasting, and which it strongly retains, is certainly ameliorated by the mixture of pure air, but is not removed. While the blast continues, some of it is driven into the other parts of the mine; but when the influx of pure air ceases, it returns again, or if during the influx of pure air, a fresh volume of smoke be produced by explosions which are constantly taking place, it is not until some time afterwards that it becomes sufficiently attenuated for the workmen to resume their stations with comfort.

A consideration of these circumstances led the Author of the following invention to think that the usual operation of all ventilating engines ought to be reversed, to afford all the advantages that could be desired; that instead of using the machines which serve as condensers, exhausters should be adopted: and, thus, instead of forcing pure air into that in a vitiated state, a complete remedy could only be had by pumping out all that was impure as fast as it became so. Many modes of doing this suggested themselves, by the alteration of the machines commonly applied, and by producing an ascending stream of air through pipes, by a furnace constructed for the purpose. The latter mode would, however, have been expensive in fuel as well as in attendance, and the others required power to overcome the friction of pistons, &c. or considerable accuracy in construction.

At length, the machine represented by fig. 4, plate III, was determined upon and erected; this is so simple in its construction, and requires so small an expense of power; is so complete in its operation, and its parts are so little liable to be injured by wear; that it seems probable nothing more can be desired, where such a one is applied. It bears a considerable resemblance to Pepys' gazometer, though this did not strike the Inventor till after it was put to work. It will be readily understood by the inspection of the plate, where the shaft of the mine is represented at A; and it may here be observed, that the machine may be as well placed at the bottom of the shaft as at the top, and that in either case it is proper to fix it upon a floor, which may prevent the return of the foul air into the mine, after being discharged from the exhauster; this floor may be furnished with a trap door, to be opened occasionally for the passage of the buckets through it.

B, the air-pipe from the mine passing through the bottom of the fixed vessel or cylinder C, which is formed of timber and bound with iron hoops; this is filled with water nearly to

the top of the pipe B, on which is fixed a valve opening upwards at D.

E, the air or exhausting cylinder, made of cast-iron, open at the bottom, and suspended over the air-pipe, immersed some way in the water. It is furnished with a wooden top, in which is an opening fitted with a valve likewise opening upwards at F.

The exhausting-cylinder has its motion up and down given to it by the bob G, connected with any engine by the horizontal rod H, and the weight of the cylinder is balanced, if necessary, by the counterpoise I.

The action is obvious.—When the exhausting cylinder, E, is raised, a vacuum would be produced, or rather the water would likewise be raised in it, were it not for the stream of air from the mine rushing through the pipe and valve D. As soon as the cylinder begins to descend, this valve closes, and prevents the return of the air, which is discharged through the valve F.

The quantity of air exhausted is calculated of course from the area of the bore of the cylinder, and the length of the stroke.

The dimensions which the Inventor found sufficient for large works are as follows:

The bore of the exhausting cylinder two feet.

The length six feet, so as to afford a stroke of four feet.

The pipes which conduct the air to such an engine, ought not to have less than a six-inch bore.

The best rate of working is from two to three strokes a minute; but if required to go much faster, it will be proper to adapt a capacious air-vessel to the pipes near the machine, which will equalize the current pressing through them.

Such a machine discharges more than two hundred gallons of air in a minute: and a stream of water, supplied by an inch and a half bore falling twelve feet, is sufficient to keep it regularly working.

A small engine, to pump out two gallons at a stroke, which would be sufficient in many cases, could be worked by a power equal to raising a very few pounds weight, as the whole machine may be put into complete equilibrium before it begins to work, and there is hardly any other friction to overcome but that of the air passing through the pipes.

The end of the tunnel of the Tavistock canal, which it was the Inventor's object to ventilate, was driven into the hill to the distance of nearly three hundred yards from any

opening to the surface, and being at a depth of one hundred and twenty yards, and all in hard schistus rock, air-shafts would have been attended with an enormous expense; so that the tunnel being a long one, it was most desirable to sink as few as possible, and of course at considerable distances from each other. Thus a ventilating machine was required, which should act with sufficient force through a length of nearly half a mile; and on the side of the hill where it first became necessary to apply it, no larger a stream of water to give it motion could be relied on, than such a one as has been mentioned, that is, one equal to a stream filling an inch and a half bore, with a fall of twelve feet, and even this stream flowed at a distance from the shaft where the engine was to be fixed, which made a considerable length of connection-rods necessary.

Within a very short time after the engine began to work, the superiority of its action over those formerly employed was abundantly evident. The whole extent of the tunnel, which had been uninterruptedly clouded with smoke for some months before, and which the air that was forced in never could drive out, now became speedily so clear, that the daylight, and even objects at its mouth, were distinctly seen from its farthest end. After blowing up the rock, the miners could instantly return to the place where they were employed, unimpeded by the smoke, of which no appearance would remain underground in a very few minutes, while it might be seen to be discharged in gusts, from the valve at the top of the shaft. The constant current into the pipe, at the same time prevented the accumulation of air unfit for respiration. The influx of air, from the level into the mouth of the pipe, rushes with such a force, as instantly to extinguish the flame of a large candle; and any substance applied so as to stop the orifice, is held tight by the outward pressure.

It is now more than two years since the machine was erected, and it has been uninterruptedly at work ever since, and without repair. The length of the tunnel has been nearly doubled, and the pipes, of course, in the same proportion, and no want of ventilation is yet perceptible.

Two similar engines have since been constructed for other parts of the same tunnel, and have in every respect answered the purpose for which they were designed.

The original one is worked by the small stream of water before-mentioned, by means of a light overshot wheel twelve feet in diameter, and about six inches in breast. The two

others are attached to the great overshot wheel that pumps the water from the shafts which are sinking upon the line, and as their friction is comparatively nothing, this may be done in any case, with so little waste of power for the purpose, as not to be an object of consideration, even if the power be derived from more expensive means.

The size of the exhauster may always be proportioned to the demand for air, and by a due consideration of this circumstance, this engine may be effectually adapted not only to mines and collieries, but also to manufactories, workhouses, hospitals, prisons, ships, &c.

Thus if it were required to ventilate a shaft of a mine, or a single level, which is most freqnently the case, where three men are at work at one time, and we allow that those three men vitiate each twenty-seven and a half cubic inches of air per minute, (as determined by the experiments of Allen and Pepys,) and allowing further, that their candles vitiate as much as themselves, there will be six times twenty-seven and a half cubic inches of air to be drawn out in a minute, equal to one hundred and sixty-five.

Now a cylinder five inches in diameter, working with a stroke of nine inches, will effect this by one stroke in a minute, though it would certainly be advisable to make it larger.

With these advantages, this machine certainly deserves to be tried in collieries, or mines that suffer from peculiar gases produced in them; for it must appear evident to every person acquainted with the principles of pneumatics, that it must do all that can be wished; as it is obvious that such a machine will, in a given time, pump out the whole volume of air contained in a given space, and thus change an impure atmosphere for a better.

In constructing the machine, it is only necessary to estimate the volume of gas produced in a certain time, or the capacity of the whole space to be ventilated. It is easy to judge how much more this must do for such cases as these, than such schemes as have lately been proposed of exciting jets of water, or slaking lime, both of which projects, likewise, must fail when applied. But with such a machine as this, if the dreadful explosions of hydrogen gas, for example, are to be counteracted, it may be done by one of sufficient size to draw off this air as fast as it is generated; and by carrying the pipes into the elevated parts of the mine, where, from its lightness, it would collect.

If, on the other hand, it is desired to free any subterraneous work from the carbonic acid gas, it may as certainly be

Fig 1.

Rawlinson's Colour Mill.

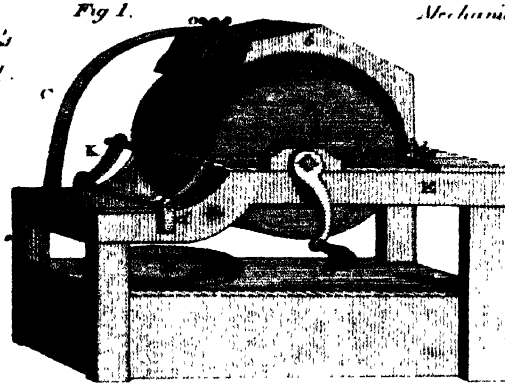
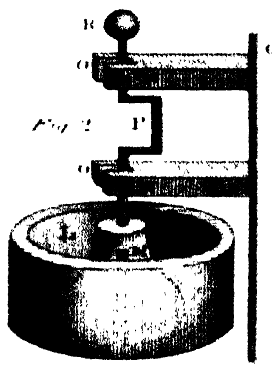
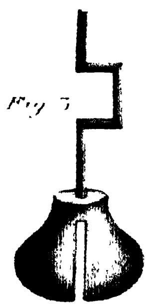


Fig 2



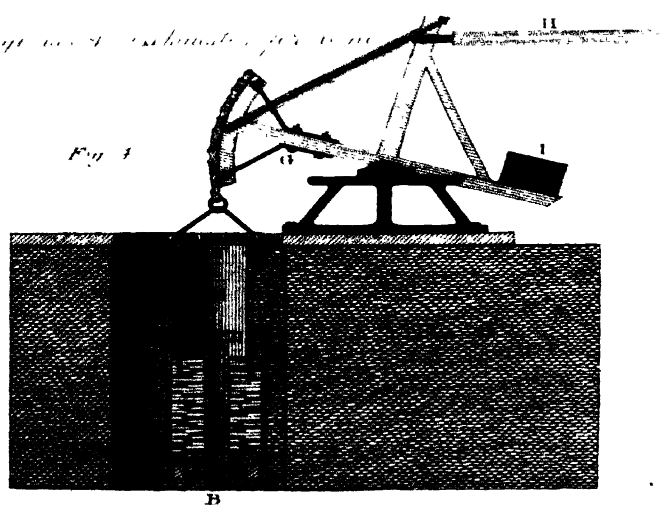
Indigo Mill

Fig 3



[illegible]

Fig 4



Published by Henry Fisher Caxton London 18[illegible]

done by suffering the pipe to terminate in the lower parts, where this air would be directed by its gravity.

In workhouses, hospitals, manufactories, &c. it is always easy to calculate the quantity of air contained in any room or number of rooms, and easy to estimate how often it is desirable to change this in a certain number of hours, and to adjust the size and velocity of the engine accordingly. Where this change of foul air for the pure, is to take place in the night, means for working the machine may be provided, by pumping up a quantity of water into a reservoir of sufficient height to admit of its flowing out during the night, in a small stream, with sufficient fall to give motion to the engine; or by winding up a weight of a sufficient size, or by many other means, which are easily devised.

If, for instance, a room in which fifty persons slept, was eighty feet long, twenty wide, and ten high, it would contain 16,000 cubic feet of air; and if this was to be removed twice in eight hours, it would require a cylinder of thirty inches in diameter, working with a four-feet stroke, four times in a minute, to do it; or nearly that. Such a cylinder could be worked by the descent of ten gallons of water, ten feet in a minute; or, for the whole time, by eighty hogsheads falling the same height.

But this is a vast deal more than could be required, as the fifty people would, in eight hours, only vitiate three thousand gallons of air, which could be removed by one hundred and fifty strokes of a cylinder twelve inches in diameter, with a four-feet stroke; the expenditure required would not be more than 1500 gallons of water properly applied, or about twenty-eight hogsheads.

The Committee of Management of the Tavistock canal, in a Report to the General Meeting of Proprietors, subsequent to the use of the above machine, after stating that great impediments had arisen from the want of good air in the tunnel, when distant from a shaft, furnish, with reference to this machine, the decisive testimony, that every difficulty, arising from the want of perfect ventilation, has now completely ceased.

A Powerful Forge Hammer.

This hammer is intended to be wrought by one or more men, as occasion requires. It is well adapted to the forging of bricklayers' trowels, rounding of ships' bolts, beating gold or tinfoil, planishing brass, copper, or, in short, for any work in which a large hammer is required upon a simple principle. The weight of the hammer is seventy pounds, yet one man will work it with the greatest accuracy and ease, and it performs the work of two or three men. The steel forged with it is kept in excellent temper; for as it does not require to be so often heated as in the common way of working, it preserves a high degree of elasticity and firmness.

This forge hammer is represented by plate IV.

Fig. 1, A, a block of oak, in which the hammer acts.

B, the wheel or nave, in which the hammer-handle C is fixed; also the chains which give motion to the hammer by the quadrant D.

EE, are the two levers which work the quadrant D.

FF, are the two pedals on which the man who works the machine treads alternately, holding the levers EE in his hands. When he treads on the right pedal F, he lifts the hand-levers EE, which motion raises the hammer C, when he treads on the left pedal, he presses on the same levers, which motion lets fall the hammer.

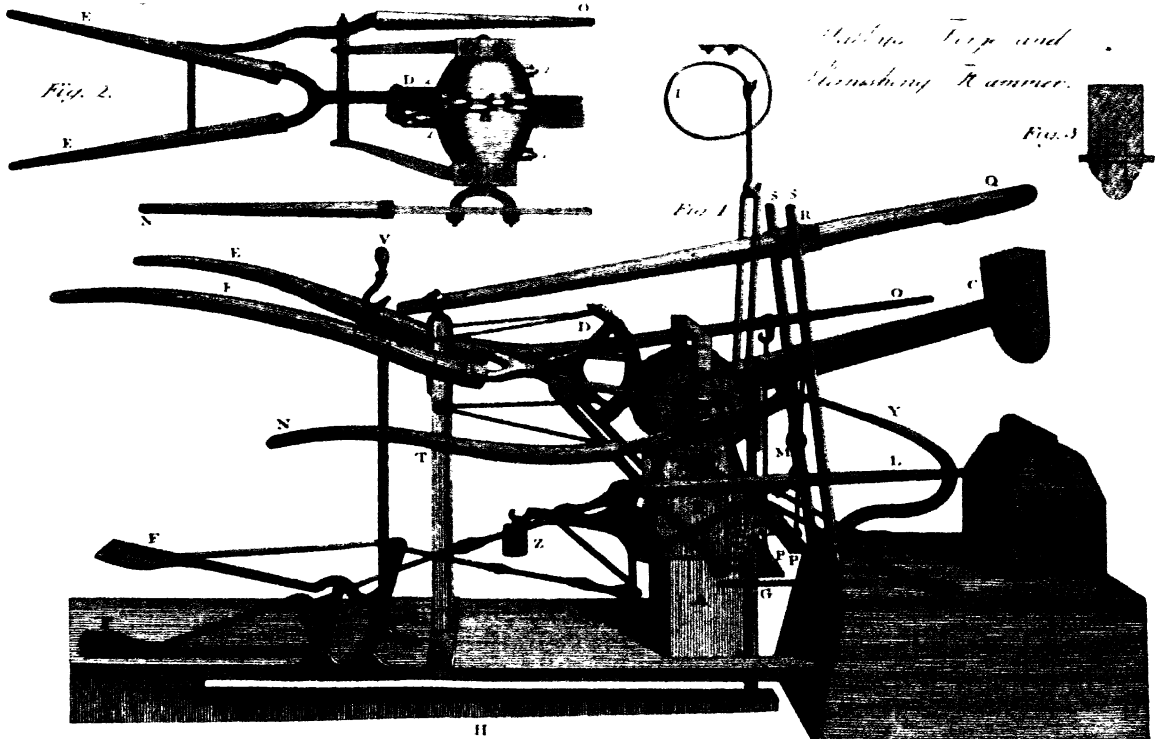
G, is a rack, which moves perpendicularly, by the action of a strong wooden spring H, placed in a trough underneath the centre of the machine; the rack is kept close to the quadrant K, by a bridge *a* containing a small friction roller.

I, an additional steel spring, fastened to the ceiling over the machine, in order to assist the wooden spring H, when fewer hands are at work.

K, is the quadrant contained in the centre of the oak block A, under the nave B, which assists in raising or depressing the hammer, by the alternate actions of the pedals FF.

L, is a lever fixed on the axis of the quadrant K, which, at the time it depresses the rack G, pulls upon the hammer-handle C, by the chain M, which adds to the power of the blow.

NO, are the two side levers, to be worked by two men, when more power is required.



Published by Henry Fisher, Caxton London, 1823

PP, are other two pedals, on which a man treads alternately, to give motion to the hammer, having an upright rod or chain to each pedal: one rod is connected from the right pedal P, to the lever O, which raises the hammer; the other rod, from the left pedal P, is connected to the handle of the hammer C; when the man treads upon the left pedal P, he acts upon the hammer C, and, by lifting the lever O with both hands at the same time, adds double power to the blow.

Q, is a wooden spring or stop, which prevents the hammer from rising too high, and accelerates the fall.

R, is a bridle, which supports the wooden spring Q.

SS, are two iron standards, with holes in each, to raise or depress the said spring.

T, is a wooden standard, to support one end of the wooden spring Q.

V, is a tempered steel spring standard, to support the hammer while out of action; it also gives ease to the springs, and prevents the heat of the anvil from softening the face of the hammer.

U, is a solid block of oak, on which the anvil stands.

W, the anvil, with a hollow dove-tail on the top, for the reception of different faces, as the various kinds of work may require.

X, a steel face, dove-tailed in the anvil.

Y, a steel spring, which lies beneath the hammer-handle, but only touches it when the hammer falls; this spring, when the heated metal is laid upon the anvil, and in a soft state, prevents the hammer from falling upon it with its full force. It gives a recoil to the hammer, and permits the workman to modify or shorten the stroke of the hammer, with quickness, ease, and regularity.

Z, a weight hung on the arm of the quadrant K, in order to counteract the power of the hammer occasionally, when light work is to be forged.

Fig. 2. is a bird's eye view of the hammer-wheel, and is marked with similar letters to show the same parts.

1, 1, are chains by which the rack G raises the hammer.

2, 2, are chains which raise or depress the hammer, by the motion of the levers EE.

Fig. 3, is a hammer-head, with a face let into it; and which face may be taken out and changed, to suit different work.

A Fire-Escape.

This fire-escape is calculated for the use of a parish, and is admirably adapted to the very important end the Inventor of it proposed to accomplish. It principally consists of three ladders, ABC, plate V, applied to each other by four clasp irons on the top of each of the two lowermost, which are so contrived that each ladder may slide into the one beneath it. On the top of the lowermost ladder A, two pulleys are fixed on the inside, over which two ropes *a a* pass, and are situated between the lower one A, and the middle one B. The ropes are made fast to the bottom of the middle one, on each side, in a proper direction with the pulleys on the top.

The uppermost ladder C, is attached to the middle one in the same manner, and on the top of it carries two horn-pieces D, made of iron, and turned off at each end, similar to two horns, which are four feet wide; their ends are sharp, to pitch on each side of a window, and with their points to hold the ladders steady.

The three ladders, when shut down, are about fifteen feet in height. They are placed perpendicularly, in the middle of a framed carriage EF, of nine feet six inches long, and five feet six inches wide, mounted upon four wheels, F.

On each side of the carriage a windlass is affixed; that marked G, on the right side of the carriage, is for the four ropes, *a a*, and *b b*, fixed two to each ladder AB. By turning this windlass, the ladders may be wound out from their standing height of fifteen feet, to forty. Over this windlass is a screw, turned by the winch *d*, by turning which, the ladders may be inclined against the house, with all imaginable ease.

On the top of the upper ladder C, on the outside, are two pulleys, over which two chains are conducted to the windlass H, on the left side, for the purpose of carrying up a box I. Two boxes of this description travel with the fire-escape, so that in the event of one being filled with small valuables, it may be unhooked, and the other, K, put on, which will save time.

The whole of this apparatus may be drawn by one horse, or six men, and when arrived at the scene of danger, may be adjusted in two minutes. If every parish were provided with it, and kept it where it might be brought out without delay, there cannot be a doubt, that many of the serious accidents



occasioned by fires would be prevented. The key of access to the machine should be kept at some well known place, and the machine should be brought out at the first alarm of fire, as it offers the ready means of either ascent or descent, and possesses a great superiority over any common or parish ladder, which is useless, or next to useless, unless it accidentally happens to be of the right height.

Machine for Boring the Cylinders of Steam Engines, Air Pumps, &c.

For this machine a patent was taken out; the specification of the patent was dated Dec. 22, 1802, and the term of exclusive right is therefore now expired; but if this had not been the case, it would have been no objection to the giving publicity to the construction of the machine, whether the interest of the public or of the patentee were considered. If the latter is benefited by imparting the liberty to adopt a useful invention, the former is also benefited by the purchased privilege; but it is antecedently requisite that an invention should be known to those who need its assistance, and to this every vehicle for conveying a description of it contributes. It is also to be observed, that an acquaintance with all improved methods of working and combining machinery is valuable to the ingenious mechanic: as even those contrivances for which he has no direct or immediate occasion, may afford hints importantly available in undertakings not apparently connected. These general remarks will apply, without repetition, to all the other patent inventions noticed in the course of this work; and it will therefore suffice hereafter, merely to notice the date of the specification, when the term is not entirely expired.

The new boring machine consists of an apparatus so contrived that the axis of the cylinder intended to be bored is preserved in a vertical position, instead of the common horizontal position. By this means, the sand and borings from the face of the metal fall down, instead of occupying one side of the cylinder, and wearing away the edges of the cutters, so as to require them frequently to be changed, and to cause

an irregularity in the figure of the cylinder, and render it much less effectual for steam-engines, or any other piston work, in which it is essential the fittings should be very accurate. By the new method, the finishing part of the cutters is employed upon a clean face of metal; and not being encumbered with the cuttings, the cutters go completely through from first to last, without requiring to be changed, by which means the cylinder is bored with the utmost precision.

Fig. 1, plate VI, represents a section of the machine.

AA, represents a circular pit, walled with stone or brick, about four feet deep; cast-iron bolts, as *a a*, are firmly built and bedded in the masonry of this pit, for the purpose of screwing down a cast-iron ring, FF, on a level with the mill-floor.

BB, is a strong iron-plate fixed in the building of the pit, and serving to afford a proper support for the gudgeons of the horizontal wheels.

KK, represent two mitre gear wheels communicating motion from the first mover.

D is a wheel upon the same arbor as K, and serving to drive another horizontal wheel C, into which last wheel the boring rod GG is inserted, and by which this boring rod is carried round.

FF, represents a horizontal, strong, metallic piece, formed of eight radii or arms, in which are grooves open to the upper surface, proceeding from the centre, where the brasses or collar of the boring-rod is lodged. This horizontal frame is very firmly screwed to the iron bolts in the masonry. It serves to support the standards HH, which (in grooves represented by the dotted lines) can be slidden to different distances from the centre, and there fixed, by screws with T heads adapted to the grooves, so as to retain the cylinder by means of the clamps II.

JJ, represents the cylinder fixed below by the clamps II, and above by screws, *q q*, proceeding from a strong metallic ring, represented at PP, which ring is made to slide along the inner limb of the uprights LL.

LL, are two very strong uprights of cast-iron, screwed to the bottom ring F, and supporting the cross beam SS, which contains the upper collar and brasses for the boring rod G. The inner limbs of these uprights are perforated, for the purpose of fixing the sliding ring PP at any elevation.

MM, is the boring head, carrying the cutters as fixed in the sliding collar N.

OO, are two racks, which carry the boring head down the cylinder.

RR, is a strap, embracing the boring-rod and wheel T, which last is by that means carried round.

The train of wheel-work, UVWX, in the usual manner of tooth and pinion work, produce a slow motion in the arbor Y, which, by means of the pinions ZZ, cause the racks, OO, to work the boring head downwards.

From the above description of this machinery, every competent workman or engineer will easily understand the mode of operation, and will be enabled to adapt the principle to his particular views. It is obvious, that the communication from the first mover to the boring rod G, may be varied as to the number and figure of the wheels necessary to produce the various degrees of speed requisite to bore different sized cylinders, and such combination will in a great measure depend upon the nature and velocity of the first moving power. The slow motion of Y may also be effected by other trains of wheel-work, or by a screw, and by various other well known methods.

The central rack *f*, with the pinion *b*, the drum *c*, and the wheel and pinion, *d e*, connected therewith, and turned by a winch, form one of the various methods which may be employed to raise the boring rod out of the cylinder, when the work is completed, or to change the boring-head and cutters.

To those who may not have fully considered this subject, the following observations, to evidence the superiority of the vertical method of boring over the horizontal or common plan, may prove interesting:

It is well known, that a hollow metallic cylinder, when laid in a horizontal position, has, from the pressure of its upper parts, a tendency to assume the elliptical form, that is, the horizontal diameter of the cylinder will be greater than its vertical diameter; and this, in a greater or less degree, in proportion to the size and strength of the cylinder. This deviation from a truly cylindrical figure is rendered still more considerable by the chains and force employed to fasten the cylinders to the frame or carriage, while bored in the usual method. This source of inaccuracy, (which has proved of so much moment in slender and large cylinders,) and has been so much and so justly complained of, is totally done away by the new method of boring, in which the cylinder itself standing vertically with respect to its axis, has no tendency to change its figure, and the screws, clamps, &c. made use of to fix it

immoveably in its position, proceeding from the arms in the upper and lower metallic rings of the machine, embrace the flanches, or other parts of the cylinder most capable of resistance, in so many points, and on all sides so equally, that not the least deviation from a true circle is discoverable in the finished bore. The importance of this essential property in steam-cylinders, pumps, &c. is too evident to be insisted on. The destruction of steam, loss of power, and frequent renewal of expensive packages attendant upon an untrue cylinder, working barrel, &c. are too well known by every practical engineer, and too severely felt by every intelligent proprietor of such an engine, to require any particular exposition.

Besides the great superiority in the precision of boring, from the cause last mentioned, and the evident advantage of boring through without change or alteration in the cutters, and from this cause obtaining a bore more uniformly exact and smooth than can possibly be produced in the horizontal mode, the comparison with regard to time and attendance, in performing the same work, is likewise of great consequence. The Patentee observes, that from the experience he has had in both methods of boring, he is fully enabled to state, that of the time necessary to fix and bore a cylinder, after the horizontal mode, at least three-fourths may be saved by the adoption of his plan, in cylinders of moderate dimensions; but those of large diameters he can fix and bore completely in one-fifth or one-sixth of the time usually required to do the same in the way hitherto followed.

From an inspection of the machine, it will also appear, that by having a knowledge of the speed of the sliding head and the cutters, and also of the train of wheel-work impelling the same vertically down the cylinder, the precise time of boring any article may be exactly known, and will always, in the same gear, be proportionate to the length of that article. Hence no attendance will be necessary, from the commencement of the work to its completion. But in the common mode of boring, attendance must be constantly given by one, if not by two persons, either to press forward the cutters by hand and lever, or frequently to change the position of the levers in the axis of the pinions, and to raise the weights, &c. and should any neglect occur in the finishing course, the cylinder must at least be bored again, and perhaps may prove irreparably injured.

Method of obtaining Pipes and Columns out of solid Blocks or Slabs of Stone.

For this invention, like the preceding, a patent was taken out; the specification of the patent is dated January 15, 1810. The invention chiefly consists in the application of hollow cylindrical saws to the cutting of stone.

When the Patentee intends to form a pipe or hollow cylinder of stone, instead of cutting out in useless scraps, or grinding to powder, the whole diameter of the bore, he cuts out a core or solid cylinder, whose outside diameter is only about half an inch less than the inside diameter of the pipe. In like manner, when he intends to form a column or solid cylinder, or a disc of stone, instead of breaking off, cutting, or chiseling away the superfluous parts of the stone, these parts are formed into a hollow cylinder, the core of which is the solid cylinder or disc required. Hence, if the stone is large enough to leave the outside parts of a proper thickness, these parts may be used as a pipe; and the core may either be used as a solid cylinder or column; or by a further operation, it may be converted into a pipe, and the cylinder cut out of it may again be converted into another pipe, which process may be continued till the core cut out is two small to be useful. The Patentee accomplishes his object by the following means.

He fixes the block of stone to be perforated in an upright position, or in such a position that the axis of the bore or intended column or disc, may be perpendicular to the horizon or nearly so.

He fixes in the centre of the intended pipe or column, a plug or step of wood or metal, shown at Z, fig. 2, plate VI, having in its centre a hole, which fits the pivot of the perpendicular axis or spindle A.

The axis or spindle A, is considerably longer than the pipe or column to be formed, and of a strength proportionate to the strain upon it. It may be either cylindrical or of any other shape, but the cylindrical form has the advantage of being most easily made straight; if cylindrical, it must contain a groove or grooves, in the direction of its length, which grooves are to receive a tongue or projecting piece from sockets that will slide up and down upon the spindle A, but are prevented by the tongue from turning round upon it; and in order that

the sockets may slide steadily, whatever be the form of the section of the spindle A, it should be uniform in thickness from end to end, at least within the range of the sockets.

Upon the upper end of the spindle A, is fixed a hollow socket BB, which fits tightly upon the spindle. The middle part of the outside of this socket is made square, or it may be of any other convenient form to receive a pulley CC, (or a small toothed wheel and pinion,) by which the spindle A may be turned round; but the upper and lower parts of the socket are cylindrical, to serve as gudgeons, on which it turns round in a fixed frame DD.

At the lower end of the spindle, near the stone to be bored, must be a wheel or cross JJ, with arms, and having a hole in the centre, which the spindle fits; and the circumference of this wheel or cross is made like a hoop, and may be two or more inches in thickness. Its diameter is a little less than that of the pipe intended to be bored, or a little more than that of the cylinder or core intended to be formed, and it fits to the inside of the tube LL, so that the latter may slide easily over it. It is fixed fast to the spindle by a screw, pin, or key, so that it may be taken off at pleasure. This wheel JJ, for the sake of distinction, may be called the fixed or lower wheel: the plan of it is shown at fig. 3, on a larger scale.

The upper part of the spindle is perforated longitudinally to O, a few inches below the socket, where the perforation comes out obliquely.

Upon the spindle A, and concentric with it, is a hollow cylinder or thin tube LL, of iron, copper, brass, or any firm material, its diameter being nearly that of the pipe or cylinder to be formed, and the length exceeding, by two feet or more, the length of the proposed cylinder or pipe. To its lower edge is fixed, by means of tin solder, rivets, or screws, a hoop or ring MM, of iron, copper, or other proper material, so much thicker than the tube, that the groove it makes in the stone may be wide enough for the tube to follow, without rubbing against the sides. The hoop or ring MM, is the saw intended to grind or cut away the stone by its lower edge; which edge is left smooth, or may be jagged like the saws used by stone-cutters. Its thickness may be varied according to the size of the tube, so as to give the necessary strength and liberty for the tube to act, but the thinner the tube is made, preserving the necessary strength, the better.

The tube LL, is connected with the axis or spindle, by means of a second wheel or cross KK, called the upper wheel

or cross, which is fixed by its circumference to the inside of the tube, having a hole in its centre, which fits the axis or spindle, so as to slide up and down easily upon it, without turning round, which is prevented by the form of the spindle, when that is square or triangular; or, when it is cylindrical, by its longitudinal groove, which receives from KK a feather or tongue, that only admits of a motion up and down. The tube therefore is always kept concentric with the spindle, by means of the wheels or crosses JJ and KK.

To one of the arms of the upper wheel KK, is fixed a small cord PP, which passes through the perforation commencing at O in the spindle, and over a pulley Q, fixed at some convenient height above it, and from that pulley to a windlass, R, to which it is attached; the use of the windlass is to raise or lower the tube upon the axis or spindle, as required, even while the latter is in motion. On the upper end of the tube, are placed weights NN, proportioned to the texture and hardness of the stone to be bored; these weights pressing downwards the saw, cause it to act upon and penetrate the stone.

The pulley or pinion CC, is fixed upon the socket which receives the upper end of the spindle; the diameter of it, the Patentee generally makes about twice the diameter of the tube LL, or of the inside of the pipe to be bored. When the apparatus is put in motion by men's force, a pulley, as shown in the plate, will be most convenient. A rope, EE, is wound round this pulley, the ends of which pass over two other pulleys, FF, one of which is fixed at a convenient distance on each side of the spindle. The ends of this rope then turn downwards, and having handles, GG, fixed to them, are pulled alternately by a man at each handle, so as to give the pulley and spindle a reciprocating or alternate rotative motion.

At a convenient distance, on one side, is placed a tub or cistern S, containing water, with its bottom as high as the pulley of the spindle. From this cistern, by the cock T, is discharged a sufficient stream of water, into a trough or conductor Y, placed in an inclined position, and with one end reaching nearly to the spindle. Sand is, from time to time, sprinkled into this trough, and is by the water carried down into the tube, which being set in motion, the saw at its lower end, assisted by the sand and water, grinds away the stone, and forms a circular groove, concentric with the axis of the spindle, and the tube being constantly pressed downwards,

the groove becomes deeper, and the water accumulates in the inside of the tube, until it can force its way under the saw, and escape by the outer side of the groove. In its passage, it carries the sand along with it, which continues the action of the saw upon the stone; and when the sand has done its office, it is carried away by the water, in the form of mud or sludge, so that the action is continued without interruption, as long as the motion of the tube is maintained. If the motion be stopped for any time, while the tube is in the position for working, it will be found difficult to free it again; when the work is stopped, it should therefore be raised up, by means of the windlass R, and the cord PP, which passes through the central perforation of the axis or spindle; the water-cock may at the same time be either stopped or not, as convenient; but if stopped, it must of course be again opened when the work is recommenced: in this manner is the process conducted, till the pipe, column, or disc intended to be formed, is completed.

By the means above described, the dead sand and sludge are removed as they are formed, and the necessity there would otherwise be of raising up the tube from time to time, in order to take out the sand and sludge by separate operations, is avoided. An essential part of the process consists in always maintaining a pillar of water within the tube, sufficient to force its way under the lower edge of the saw, and to carry the sand with it; without this, the tube would require to be frequently removed, and it would be almost impossible for the saw to penetrate beyond a few feet in depth, in any reasonable time.

When the depth of the bore, or length of the pipe to be formed, exceeds six or seven feet, a readier outlet for the water, sand, and sludge, may be made, in common work at least, by boring one or more holes, suppose about the diameter of an inch, in the sides of the pipe, and when the pipe is finished, these holes may be stopped up.

When the apparatus is put in motion by any other power than that of men, instead of the pulley CC, the Patentee sometimes fixes a small toothed wheel or pinion upon the socket BB, which wheel or pinion is acted upon by a reciprocating toothed wheel, or by a reciprocating rack; or he retains the pulley and cord, as if it were to be acted upon by men, and affixes a sufficient weight or spring, in the place of one of the handles G, and causes the power to pull the other end of the rope, by means of a crank, or other equivalent contrivance.

MECHANIC. Pl. VI.

Billingsley's mode of boring Cylinders for Steam Engines &c.

Fig. 1.

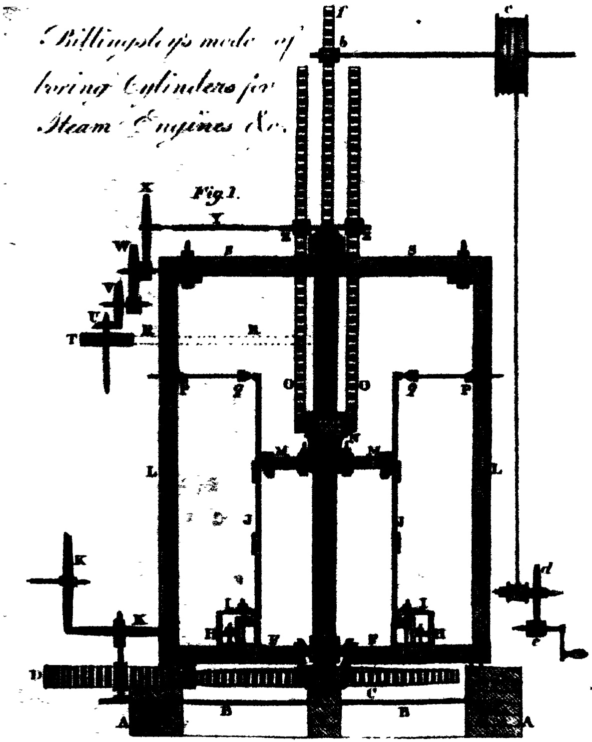


Fig. 2.

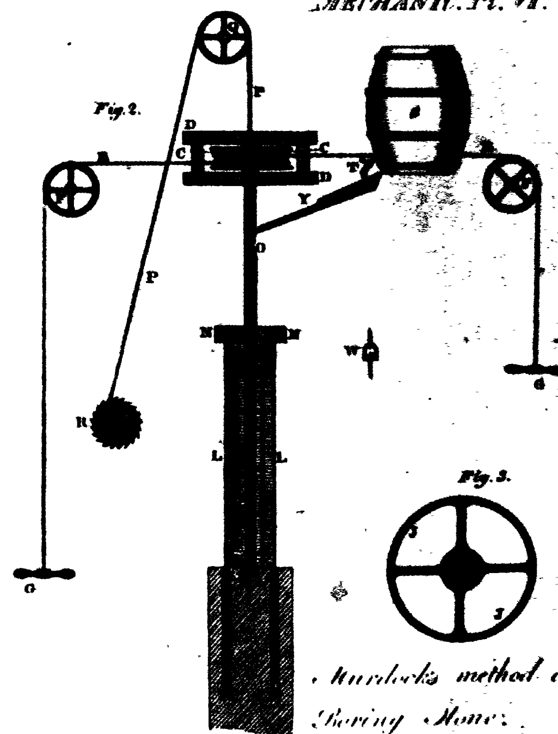


Fig. 3.

Murdock's method of Boring Stone.

When the outside of a pipe is to be rounded, as from a rough block, the operation may commence by employing the tube LL, and saw, of sufficient diameter to leave the stone strong enough round the intended pipe, and proceed with them, as before described, until they have gone down through the whole depth of the stone, leaving within them a cylinder, of a proper size for the intended pipe. Then remove the tube and saw first used, and use a tube and saw adapted to the intended bore of the pipe, and work them through: one pipe, of a regular shape both within and without, will then be formed; and it is obvious that the core remaining, may, by the use of still smaller tubes and saws, be wholly converted into pipes, of sizes differing from each other by the thickness of the groove or kerf of the saw.

In some cases it may be convenient, to turn the tube and saw with a uniform rotative motion, always in one direction; but with a motion of this sort, the work will not proceed so rapidly, as by the alternate motion above directed; where, however, a rotative motion in one direction is used, it will be found advisable to fix a swivel in the small cord PP, as that represented at W, to prevent its over twisting; and this again requires the pulley Q to be placed higher up, so as to give room to place the swivel between it and the pulley CC, to prevent its interfering with the swivel.

It is to be noticed, that as cylindrical saws have been invented many years, and used for the boring of wooden pipes, the exclusive right to use such saws for that purpose, are not claimed under this patent; but only the application and construction of circular saws above described, especially the method of grinding with the saw by means of the spindle passing through its axis, and the two crosses or wheels, one sliding upon, and the other attached to the spindle, on which the tube slides up and down. The working of the circular saw by a reciprocating or alternate motion, instead of a rotative one, and the method of discharging the dead sand and sludge by a pillar of water, or in certain cases by perforating the sides of the pipe, are also claimed as parts of the Patentee's invention.

On the Preparation and Uses of Ships' Boats as Life-Boats.

The Author of the following plans having, a great many years ago, witnessed a melancholy scene of shipwreck, and seen men perishing at little more than the distance of one hundred yards from the shore, was forcibly struck with the reflection, that though there was no possibility of getting from the shore to them, yet there was a great probability that means might be found, by which those in such situations might with safety be enabled to effect their escape to shore; and further considering that the very precarious aid of some accidental piece of wreck (under every disadvantage, and in a tempestuous sea) sometimes serves to save life; he was confirmed in the opinion, that some method might be devised, which, upon good grounds, would hold forth the promising prospect of safety in all the common and general cases of shipwreck. Hence it was, that to devise such a scheme, became the object of his research ever after.

The plans now proposed (especially the first) are so simple, and the effect so obvious, that seamen will not entertain a doubt, but that a boat so prepared, would live in any sea whatever; could neither sink nor overset, and would carry in safety a number of people, in proportion to her size, over a bar, or from the wreck to the shore, through any surf.

That empty casks will float, almost wholly above the surface of the water, is so clear, that no person can be so absurd as to question it; and it is equally certain, that every cask will support weight of any kind in proportion to its size. In order then to accomplish the end proposed, there is only one thing more wanted, and that is, by sufficient seizings or holdings, to secure the casks in their places. Were a seaman to be told that he is not master of this mighty operation, it is easier to conceive than to express the contempt he would feel, and the energetic reply he would probably make to such a supposition. If, then, these are undeniable points, it must follow, that wherever the boat can be had recourse to, all that is contended for in the plan must be granted.

It no doubt has been upon these simple and obvious principles, that those corporate and public bodies, and hundreds of seamen, to whom the plan has been communicated, have

so readily and entirely approved of it. But, however respectable and authentic such testimonies may be, they are not alluded to with a view to supersede investigation; the statements here brought forward, are freely submitted to the great body of seamen in general, for them to judge of, not with liberality only, but with severity, as it would be a crime of the first magnitude, to advance a single argument or suggestion that could have the smallest tendency to mislead, in a matter so solemn and important, as where life and death are concerned.

Mariners are unavoidably exposed to incomparably greater hardships and sufferings, than what are to be met with in any other line of human life. Whilst the labours of all others are moderate, and find relief at stated intervals by day, and repose by night, the seaman must contend with the storm so long as it lasts, encounter danger at a moment's warning, whether at mid-day or mid-night. While the tempest rages, no respite can be allowed him; he must keep his station without intermission, and after toiling above strength and above measure, it is often his hard fate to be shipwrecked at last.

The complicated distress attendant on this frequent and fatal disaster, it would be in vain to attempt to describe in any words; nor is it possible to conjecture nearly the number which is added annually to the innumerable multitude of dead which the ocean contains.

Sometimes several hundreds in one ship are involved in this direful calamity, where the misery of each sufferer is increased, in proportion to the accumulated woe that surrounds him; the cry of despair is heard on every side, and in distraction each exclaims, What shall I do?

Amidst overwhelming waves and wrecks, the mariner suffers, in his person, all that a living man can undergo; and in his mind, all the anguish that despondence can create, heightened by the agonizing thought, that he is never more to behold wife, child, family, or friend; still, however, amidst all his sufferings, an ardent love of life prevails, and the hapless mariner, struggling hard to preserve himself, clings to whatever seems to promise a momentary reprieve.

In the mean time, the wreck is rapidly giving way; some are washed away in one place, and others in another; those who remain, redouble their efforts for life; but, alas! they strive in vain; one decisive blow has dashed their last and only support in pieces, and all are going down together—a general shriek is heard—to be heard no more! the melancholy scene has closed, and neither survivor nor wreck is left behind.

Any plan that has for its object to afford relief in situations of such extreme distress, and which seeks to extend the same benefit to thousands of perishing men in future ages, will no doubt meet with a favourable reception from every humane and benevolent mind. But humanity and true benevolence, are not merely speculative, but active principles; and wherever they really exist, the helping hand is instantly stretched forth, to execute the dictates of the feeling heart.

On a subject so interesting to individuals, and so important to society, may it not be expected, that every friend to humanity and to his country, will not only heartily wish success to the present plan, but also lend his best assistance to have it brought into all the practical effect, of which it may be found susceptible?

It is to be understood, that the plan is intended to apply to cases of shipwreck in general, and that it may very often succeed, even in cases of extraordinary difficulty and peril. This will comprehend the far greater number of all shipwrecks that happen, and the Author thinks himself warranted to say, that no solid objection can be offered to the effectual operations of his plan to this exent, and that it will be found fitted to answer all the purposes of a life-boat, by saving lives, where otherwise men must inevitably have perished. At the same time, it must be observed, that he does not speak with this confidence from his own opinion only, or on theoretical grounds, but because the plan itself, after repeated investigation, has received the unanimous testimony and approbation of professional men, and of those who must be allowed to be the most adequate and respectable judges in the kingdom. The Trinity House of Leith, the Highland Society of Scotland, the Trinity House of London, the Royal Humane Society, and more than one hundred ship-masters, whose attestations were in the possession of the Inventor, so early as the year 1809, have all given their testimony decisively in favour of the plan. The Inventor, besides, speaks from the result of forty years' experience in the use of boats, among dangerous tideways and rapid currents, such as the Pentland Frith, and all the other channels among the Orkney Islands; having been several times at sea, in storms that were attended with shipwreck; and from such experience he is perfectly convinced that his plan is sound and unexceptionable, and confidently hopes that the period is not very distant, when it will come into as great repute and general use as life-boats, properly so called, are now known to be.

The plan may be executed upon boats of all dimensions, and the largest, provided they could be got out, would be found the most advantageous; but all circumstances considered, the size deemed in general best adapted for the purpose, would be any boat from sixteen to twenty feet in length, which is to be prepared according to the following

DETAILS OF THE PLAN.

Two additional ring-bolts are to be fixed in the keel withinside of the boat.

One to be placed one-third of the boat's length from the stem.

The other one-third from the stern.

Two auger holes are to be made through the keel, without side, and close to the garboard stroke.

One of these bores to be put half way between the ring in the stem, and that next to it in the keel.

The other about half way between the ring in the stern, and that next to it in the keel.

Plugs may in ordinary be put into these bores, to be struck out when occasion requires.

Those ring-bolts which are in ordinary in every ship's boat, the two additional ring-bolts in the keel, and the two auger-bores, are all intended as secure points of fixture, to which seizing ropes are afterwards to be attached.

In the next place, two tight empty casks, see fig. 1, plate VII, are to be provided, of such dimensions that their length may fit to the width of the boat, when laid athwart ship, and their diameters to be about three feet, and if larger so much the better.

Each cask must be furnished with a sling on each end, and each sling to have two eyes on it, about six inches asunder; and the slings so put on the cask as that the eyes may be on the upper side when laid into the boat, that the seizing rope may pass through those eyes, in their way from ring-bolt to ring-bolt.

One of these casks, so prepared, is to be laid in foreward, and the other aft; and each cask so near its respective ring in the keel, as only to leave sufficient room for passing the seizing rope through the ring in the keel.

By this means, the vacant space to be then filled up with cork, will be left between the cask and the bow foreward, and between the other cask and the stern aft.

The requisite quantity of cork, according to the dimensions of the boat, and the quality of the cork, may be about a hundred and a half, or two hundred weight, for each end of the boat; and that for each end ought to be made up into two separate bundles, each bundle being fitted to the width of the boat, and the uppermost one forming an arch from gunwale to gunwale.

The cork is to be made up in canvass, done over with soft pitch for preservation, and each bundle marked and numbered according to its place.

The cask and cork being laid into the boat, seizing ropes are then to be applied for securing them in their places.

Here it is to be observed, that the single turn of rope, which is to go through the auger bore in the keel and round all, should be the first made fast, that the other seizing rope (which we shall suppose to have been made fast to the ring in the stem) may, in passing through the eyes on the sling, take in the surrounding rope between the two eyes, which will thereby prevent the surrounding rope from slipping to either side of the cask.

The seizing rope having passed through the eyes on the sling, is then to be passed on through the ring in the keel, and thence back again in the same manner, through the eyes on the sling on the other end of the cask, to the ring in the bow; and lastly, the seizing rope is to be brought directly from the ring in the stem to the ring in the keel, by which it will cross the cask at the bung or middle part of it: the other cask and cork aft are to be secured in the same manner.

The preparation will be completed by attaching a bar of lead or pig iron, of about two hundred weight, to the keel within-side, by means of the ring-bolts in the keel or otherwise.

The same plan may be executed with equal effect, and nearly with the same expedition, by the following alteration and arrangement.

Instead of one large cask, two lesser ones may be used in each end of the boat.

These are to be laid in lengthways, fore and aft, in the boat, along-side of each other, and both together ought to fill the width of the boat.

These must also be furnished with slings on each end, and with two eyes on each sling; and these eyes are so placed as to be about two inches above the horizontal diameter of the cask, one eye being on each side of the cask, when the sling is put on.

The seizing-rope being now made fast to the ring in the stem, is to be passed through the eyes on the slings on one side of the cask, then through the ring in the keel, and so back again through the eyes on the slings on the other side of the same cask, to the ring in the stem. The rope is then continued on till it has passed in the same manner on both sides of the adjoining cask, and the last turn is to be made directly from ring-bolt to ring-bolt, passing over and above the surrounding rope, which will thereby be brought down in the middle between the two casks, and made closely to compress them on each side.

The same process is to be followed as to the casks aft, where the dimensions of the boat will admit of it, and where otherwise one large cask athwart ship may be used, as in the plate, fig. 2. It was in this manner that a successful experiment was made at Leith, and all the cork that was used on that occasion, was about one hundred weight, put into the narrow part of the boat aft, in order to raise a common porter-cask placed above it to a convenient height. The preparation of the cork bundles, in this case, will differ somewhat in their shape from those in the former plan; but as the purpose of them is the same, namely, to fill up the vacant spaces between the cask and the boat, a particular description of them seems quite unnecessary; only it may be observed, that as the diameters of the cask foreward, are considerably less than in the former plan, so much of the cork ought to be placed underneath, as may serve to raise the upper side of the cask about four inches above the gunwales; it being evident, that the higher they can be raised with sufficient security, the more effectually all possibility of overturning will be prevented.

The same quantity of ballast is to be used in this case as in the former, and is to be applied in the same manner.

With respect to boats of small vessels, a single cask foreward and another aft, without any cork, will be sufficient.

Each cask to be about the size of a hogshead, and to be set on end, or leaning obliquely towards the rings in the stem and stern, to which they are to be secured, and at the same time to two other rings placed in the keel, proper for that purpose. These casks, from their position and power, would effectually prevent sinking or upsetting; and as the crews of such vessels are few in number, their boats might support them safely through any breach into shallow water.

The foregoing plans are founded upon unquestionable principles, and constructed according to a regular method:

They keep in view the difficulties to be encountered, and provide against them by making a few necessary preparations in due time. Were this attended to, all the confusion and embarrassment which arises from sudden alarm, and the distress that must attend the total want of suitable means, would be prevented, and an encouraging prospect of safety held out, even in the most perilous situations.

The want of timely forecast, and the neglect of means that were in our power, never fail to occasion the bitterest self-reproach, and the most painful vexation, whenever we are overtaken by misfortunes, which a little prudence might have prevented.

As there is, however, too much reason to apprehend that such prudential provisions as have been stated, will still be neglected, in spite of every suggestion and consideration that can be urged, a third plan will now be proposed, which, though inferior to the former, as a ship with jury-masts, torn sails, and a temporary rudder, is to one in perfectly good condition; yet may this inferior plan, like the disabled ship, gain what was despaired of, and save what was given up for lost.

The third plan consists in the application of casks only. These, if stowed closely, so as to fill up as well as possible, one-third part of the boat foreward, and one-third aft, would effectually prevent the boat from sinking or oversetting.

Upon this plan, in order the better to secure and combine the cask, the end of a sail should be in the first place thrown into the bottom of the boat, and the cask being stowed upon it, the other end of the sail should then be doubled over all: the seizings are then to be made through holes struck anywhere through the bottom and sides, wherever the passing of a rope may be found necessary, or of any use for confining the cask.

The constant and general idea, that the utility of every boat depends upon the tightness of her bottom, and her completely resisting the admission of water, opposes itself strongly, and almost irresistibly, to the directly opposite idea, that water freely admitted could do no injury; nay, so strong is the received opinion, that it may be very difficult to persuade some, that large openings in the bottom would prove a real advantage; it is, however, undoubtedly true, that in the present plan this would really be the case.

It is therefore very material to observe, that neither the number nor the size of the holes struck through, are of any

consequence, as to the water in the boat; on the contrary, they would be so far from being detrimental, that, to a certain extent, they would be of advantage, as they would serve to discharge, in proportion to the buoyancy contained, whatever top-water might be withinside, above the level without, and which the boat would otherwise retain as a load and dead weight, if she were every-where perfectly tight; whereas, in proportion as the buoyant power operated in raising her, the top-water would instantly subside through the holes in the bottom, and thereby render her more lively, and to swim higher out of the water.

From not attending sufficiently to the fact now stated, it has probably happened, that the plan at present described, has never been attempted; but whoever will take the trouble a little to consider the matter, will be convinced that they may, *without scruple or hesitation, make as many holes, and of whatever size*, as they may judge necessary for passing ropes, wherever they can serve for effectually securing the casks in their places.

The only point chiefly to be attended to, is never to attach ropes to any tender part of the boat, such as the gunwales or thwarts, but to such parts as possess the greatest strength, and in which entire confidence may be placed.

As the largest boats have strong timbers, this plan might probably succeed best if applied to launches and long-boats.

Small anchors that have iron stocks, and which could be laid in the bottom of the boat, would serve for ballast, though probably ballast in large boats would not be very necessary.

The holes to be struck through, may be pierced with a marline-spike and mallet, between the timbers.

The power and effect of empty casks is well known, the application of them being a common expedient, used almost every day, for the purpose of floating stranded or bilged vessels of great burden. How easily, then, by the same means, a boat may be rendered buoyant to any degree that can be wished, must be abundantly evident to every person not obstinately blind to undeniable fact.

The thing is so self-evident as to require no proof, that if both ends of the boat be tolerably filled with empty casks, she will not only thereby be secured against upsetting or sinking, but will be rendered extremely buoyant, provided the casks be effectually secured in their places: the experiment instituted at Leith, as before alluded to, was made almost entirely with empty casks, and fully proves this fact.

The Inventor having little hope that the far better and more eligible plan, by timely preparation, will be adopted, is the more solicitous to gain attention to this third mode, by means of cask only, because necessity, which is often the mother of persuasion, as well as of invention, may compel the unfortunate mariner to have recourse to it.

Seamen above all others, are expert in the use of ropes, and expeditious in making secure seizings, and these are the great and only requisites in this case. Let, therefore, no scruple or hesitation be made in striking holes through the boat any-where, and of any number or size that may be found necessary for passing ropes that may effectually confine the casks. This plan will apply, *not to one boat only, but to every boat in the ship,* provided there be a sufficiency of casks on board.

If then those two great points, namely, the powerful buoyancy of cask, and the peculiar expertness of seamen in every operation where ropes are to be used, be duly considered, they will sufficiently vindicate and verify all that has been stated; and unless the one or the other, or both (that is, the power of cask, and expertness of seamen) can be shown to be false assumptions, the conclusions which have been drawn can neither be denied nor resisted.

OBSERVATIONS AND REMARKS RELATIVE TO THE FOREGOING RULES.

1.—From the detail in the description, it may be alleged that the situation would not admit of so much time as the preparation would require.

It is granted, that, in some cases, this might be true, if nothing had been done before-hand; but surely such neglect ought by no means to be imputed as any defect in the plan, but ought to be ascribed to its true cause, the remissness of those who would give themselves no trouble to avail themselves of it.

Slings fitted to the cask, two additional ring-bolts, two auger bores, and the requisite quantity of cork, are all things so trivial and so easy to be provided, that to be without them must appear an unpardonable neglect; and if these were in readiness, the short space of ten minutes would be quite sufficient for laying them in their places and securing them.

It is evident to demonstration, or it might be easily proved by experiment, that with respect to the two first methods stated, and where the necessary provisions had been made, that the whole could be executed in ten minutes, and therefore any objection in point of time can have no place.

2.—When there is a prospect of the ship's holding together for some time, the boat may be kept in readiness and in reserve, or may be served on shore by a rope, and hauled off again, as often as occasion may require; and if to be hauled off, it might be a necessary precaution to pass a rope round her lengthways to assist the ring-bolt in the bow; and in every case, the attachment and connexion of the boat with the vessel ought to be well secured till the moment she is to be cast off for the shore.

3.—It is of no consequence in what manner this boat is got into the water, whether after-end or side, by means of handspikes or otherwise, as no water can hurt her, though it might be more desirable, if it could be done without filling her in midships, as in that case she might be conducted through very heavy seas without filling at all, or receiving more water than might be easily baled out.

4.—It is material to remark, as it may not generally be attended to, that the plan always supposes the midships to be full of water; but that the requisite buoyancy of the boat is not injured by that circumstance, nor will the addition of people, in so far as they are immersed in the water, prove any additional burden. This will be perfectly clear to all who understand this part of the subject, however improbable it may appear to others; and the remark serves to show that it would be a good rule, in such circumstances, for the men to keep themselves immersed in the water in midships as far as possible.

The idea of placing men in the midships of the boat, whilst it is full of water, would probably startle a landsman not a little; such, therefore, may be told, that every life-boat is supposed to be full of water, and that to imagine there could be any man in one with a dry thread about him, would argue a total ignorance of the matter.

5.—It is to be kept in mind, that the danger is always supposed to be extreme, and that the present plan affords the only possible chance of saving life; therefore whatever hardships or difficulty there may be in putting it in execution, is entirely out of the question: any other view of the subject is altogether foreign to the purpose.

6.—If any are of opinion that cork ought alone to be used for buoyancy, there can be no doubt of its answering the purpose perfectly; but at the same time there are good reasons for preferring a combination of cork and cask.

Water-casks would always be at hand, and to save the expense of cork, might on that occasion be preferred by some; but independent of this consideration, casks are, by more than one half, lighter than their bulk of cork, and thereby more than a double advantage in favour of buoyancy is gained by using them.

There is but one objection to the use of casks, which is, that they may be stove in; but if the great strength they possess from their construction be considered, and at the same time that they are strongly defended by the boat, this objection must appear of no moment at all.

7.—Every boat, as has been stated, is fit to carry men equal in weight to something more than one-third of the boat's own burden, and one of eighteen feet in length, can carry from fourteen to sixteen people, and have sufficient room for working a pair of oars, which ought by all means to be short ones.—The disadvantage of working long oars upon a low gunwale, and in a high running sea, is too obvious to need any more than to be just mentioned.

8.—As all depends upon the points of fixture, too much attention cannot be paid to their sufficiency; and though those stated in the plan, are judged to be perfectly adequate to the purpose, yet any person wishing for more, *may add to them at pleasure*, by rings of rope in the stem and stern posts, as in the Greenland boats, by more rings in the keel, or in addition to the seizing-ropes, a netting of small rope may be made to cover the whole foreward, and another such may be applied in the same manner aft; and by these means every possible security that can be desired may be obtained.

9.—It is material to observe, that no dependence ought to be placed on seizings connected with the thwarts or gunwales, unless it were only as aids to the point of main dependence.

The gunwales, more than any other part of the boat, are liable to damage, and may very possibly be injured in hoisting out, or before getting clear of the vessel.

The two auger-bores in the keel are infallible holds; easy access may be had to them while the boat is on deck, and a rope may be passed through them in a moment. This seizing, besides the security it affords for confining the buoyancy, adds

considerably to the strength of the boat, and therefore ought to be preferred to any other mode of fixture.

10.—No rule can be laid down that will fit all boats, as to the precise quantity of cork, or size of cask, their shape and dimensions being so various; but from the general rule that has been stated, and the purpose to be served, every man may easily adjust his apparatus to his boat, or make such little alteration on the boat as may be found convenient or necessary.

11.—No sail can hurt this boat, as it is supposed she has only to go before the wind, and therefore a sail may be used with very great advantage. This would render oars unnecessary, and would be infinitely preferable. It is almost needless to add, that the boat could be steered in midships.

12.—The great benefit derived from the common life-boats is well known, and universally acknowledged; but they are very far from being adequate to the calamity they are intended to remedy. Their number comparatively is very few, and the sphere of their operation extremely limited. In darkness by night, and thick snow by day, when their aid is most wanted, they are of no avail. Storms may blow, and sometimes have blown, so hard as to defeat their utmost exertions, and even in the most favourable cases, they require a considerable time before they can reach the wreck;—in the mean time, the vessel may be dashed to pieces, and all hands lost.

The very pre-eminent advantage of the ship-boat, in these and several other respects, is very conspicuous. This boat is wherever the ship is, and recourse may be immediately had to her; is of equal utility by night as by day, and in the thickest as well as in the clearest weather; and whilst the life-boat, with extremely slow process, must be impelled against wind and sea, by a force superior to both, the ship-boat has only to drift with ease before the storm.

13.—As it may serve to gain confidence with those who are not otherwise qualified to judge of the plan, it may be observed, that the ship-boat is prepared upon the very same principles as the life-boat, and that these principles are applied to greater advantage in the former than in the latter. The quantity of buoyancy in the ship-boat, being considerably more in proportion to her size, and being carried to a greater height, gives more security against oversetting; and if to these advantages there be added the far greater one, of having to drift before wind and sea, no shadow of doubt remains of the success of the ship-boat over that of the other.

Lastly.—This plan carries with it the very strong recommendation of private interest as well as of public utility.

Suppose a ship to be riding in an open bay or road-stead, a storm comes on, and if in winter, a long dark night is soon to follow. In this situation, the mariners being extremely doubtful whether the vessel will hold out over the night, and terrified at the awful prospect of being thrown, as it were, blindfold into the most perilous of all situations, the determination would most undoubtedly be to cut and let the ship on shore while there was light, as giving the only chance for saving life. The same determination may be taken in hopes of escaping by favour of a falling tide; and in both cases, lives, ship and cargo may be all lost, as has certainly very frequently happened. Whereas, could safety be ultimately relied on from the boat, the ship would be allowed to ride so long as anchors and cables could hold her, and in the mean time the storm might abate, the wind might shift, or her tackling might prove sufficient to out-ride the storm; and thus lives, ship and cargo would all be safe.

In every situation, the prospect of safety by means of the boat, would prevent every precipitate measure, and encourage men to make those exertions for saving ship and cargo, which are not to be expected from men despairing of life.

In the foregoing plans, there is nothing that can be reckoned complex, nothing that requires nice adjustment, or of doubtful and precarious effect. They are unquestionable in principle, simple and easy in execution, and absolute in security; and if the necessary previous precaution; which is very little, has been made, they will be found as expeditious as any emergency can require. They have been proved by experiment, as far as circumstances would permit; and have received the unqualified approbation of naval men of the greatest experience, and of the first respectability.

These are the solid grounds upon which they are offered to the public in general, and most earnestly pressed upon the attention of seamen in particular.

The plan having been communicated to hundreds of seafaring men, they have always given it their ready and entire approbation; hence it is hoped, that every seaman, from his own knowledge and experience, without any doubt whatever, will, upon considering the subject, be fully convinced in his own mind that the scheme is perfectly practicable, and if adopted, would be attended with the happiest effects.

SUBSTITUTES AND EXPEDIENTS WHICH MAY BE FOUND USEFUL.

1.—If so much cork was made up in canvass, as would serve to go quite round the boat withoutside, and reach from the top of the gunwales to about fifteen inches downwards, and of one foot in thickness; the same might be attached to the boat, and would render her extremely buoyant. This, together with ballast, and a small quantity of cork withinside, would render it a perfect life-boat, upon almost the very same plan as the present life-boats.

The cork might be made up in so many separate parcels, (netted in small rope,) as was found convenient to be attached to a strong rope going round the gunwale, and to another such which ought exactly to fit the girth of the boat where the cork reached to below.

As the cork would only press upwards, and always against the bottom and sides of the boat, it is evident that if the lower rope fitted tightly, the cork would keep its place; and in order to secure that point, a few turns of rope passing from the lower edge on the one side over the keel, to the lower edge on the other side, would fix it completely. A very few seizings attached to the gunwale rope, passing from the one side to the other, would be quite sufficient.

The separate parcels must be furnished with loops, or ends for attaching them to the main ropes, and to one another.

2.—Several ring-bolts might be put into the keel withinside, and ropes, single, double, or treble, might be passed through these rings before laying in the buoyant materials, and then these ropes might be brought round the whole contents and made fast.

3.—It frequently happens that seamen, after they have gained the shore, find they have only escaped one death to perish by another still more miserable. Drenched in water, chilled to the heart with cold, worn out with fatigue, and exposed to all the severity of inclement weather, without shelter or succour, it is impossible but that the remains of life must soon be extinguished.

In this situation, and it is far from being uncommon, dry clothing would be as precious as life itself, and might be obtained by the following expedient:—

Let a *leathern* bag be made for containing some shirts, a waistcoat or two, and two pair of drawers, all of flannel.

Let this bag be made of a length and size convenient for the purpose, and for tying round under the arm-pits.

This would serve the purpose of a cork-jacket in the water, and prove a second time as life from the dead, by affording dry and warm clothing upon gaining the shore.

By this expedient every man may be made a swimmer, and sometimes one man by swimming has been the means of saving the whole ship's company.

It may be proper to observe, that the larger part of the bag should be placed high upon the breast, and the other or back part no higher than the arm-pits, as in the act of swimming, the back part of the shoulders is little more than just covered with the water.

The bag must be perfectly water-tight, and only moderately filled; both ends of it may be left open, to be closed with a tight seizing of small line.

The expence of this preparation would scarcely be five shillings.

4.—If it were intended only for swimming, a neat and commodious preparation might be made with cork covered with thin leather, to be applied in the manner which has just been described.

It might be fitted on, with clothes or without, in half a minute, and made fast by a knot or clasp on the breast; three pounds of good cork would be sufficient to support any man, and the expence would be no more than in the former case.

5.—Another expedient bids fair for obtaining a speedy communication between the ship and the shore, by means of a kite.

It is the property of this machine to ascend in proportion as the cord is spared off. To manage this, and to bring the line within reach on shore, let a piece or light wood, about the size of a small handspike, be attached to the line, about twelve fathoms from the kite; the line to be fixed to the forepart of the stick, and so as to pull only there, and then being slackly laid along the stick, made fast to the other end: by this means the kite would be prevented from rising higher, and would at the same time bring the line to the shore from the ship, and by this small line a rope might be hauled from the ship by any spectator on the shore.

A silk-handkerchief, and a piece of wooden-hoop, might soon furnish a kite.

6.—Sometimes people are seen to perish, where those on shore, and those on the wreck, are almost within grasp of each other.

In this case, if there happened to be a mast standing, a common ensign made fast to a stick, and quickly spared off from the mast head, would probably reach the shore without touching the water, or at least drift on shore with a small line attached to it.

From the obvious similarity there is between the prepared ship-boat and the common life-boat, it might be imagined that the former has been borrowed from the latter; but the Inventor of the prepared ship-boat, actually sent to Lord Melville the outline of his plan, in the year 1792, at which period, and for many years afterwards, no life-boat existed. The plan, detailed more at length, was afterwards submitted by Lord Melville, to the Elder Brethren of the Trinity House at London, and in 1800, it was submitted to the Highland Society of Scotland. These public bodies, and others to whom the plan was submitted, were unanimous in their approbation of it, and it appears incontestable, that with its Author originated the first regular attempt ever made to find a general remedy for the manifold dangers and distresses to which seamen are exposed by shipwreck.

The meritorious Author of the preceding plans, has received from public bodies to whom he submitted them, a variety of honorary and pecuniary rewards; and it would be improper to omit how well he has deserved them. His salary as a clergyman, does not amount to seventy pounds per annum; yet in repeated journeys to London and Edinburgh, to promote his benevolent views, he has been at an expense of some hundred pounds; and in short, with the most disinterested views, has persevered during a great part of his life, in maturing and bringing into notice, plans of incalculable value, not only to his country, but to the world at large.

Cast Iron Mooring Block, and improved Method of Mooring Ships in confined situations.

The mooring-block described below, from its construction and weight, is decidedly superior to any anchor whatever. As a proof of its holding fast in the ground, may be adduced the following circumstance: it was found necessary to remove

one of those which had been used at Chatham; two large lighters, with purchases in each, adapted to the purpose, with about forty-five men, were sent to weigh it; but their united powers were not adequate to the task; and it became necessary to wait for the rising of the tide to dislodge it. The largest anchors appropriated to the moorings of a ship of the line, are from sixty-five to eighty hundred weight, and those sizes are found sufficient at times, whereas the weight of a mooring-block is about one hundred and fifty hundred weight, which is seventy hundred weight more than the largest anchors in use; while its form, independently of its greater weight, is better calculated to hold: this double advantage will allow a reduction from the length of the chain; and in one pair of moorings for a ship of the line, a saving of about £874 will arise out of £2472, the present expense of a pair of moorings with anchors. Another advantage will accrue by adopting these blocks, for there are no anchors appropriated to moorings but might be made serviceable; and should there be no defective anchors in store, it becomes a matter of necessity to take sound ones. It is also to be observed, that there is no species of naval stores so difficult to procure as large anchors, from the want of anchor smiths, and that an anchor of seventy-six hundred weight will take upwards of thirty days in making, while a mooring-block can be cast at a short notice, and obtained at all the iron foundries in the kingdom.

Fig. 3, plate VII, is a perspective view of this mooring-block.

AA is the stock, made of two beams united together by hoops, and by that means fastened round the shank B of cast iron.

CCC is the fluke, made as in the figure, of such a form as to take the greatest hold in the ground, its lower edge being sharp, but of the full width, so that it has an edge, but no point.

D is the swivel which connects the shank to the mooring chain.

E is a part of the shank projecting through the fluke, having a hole through it to receive a buoy-rope to take up the anchor when necessary.

In this mooring-block, the principal part of the weight being in the fluke, the edge is thereby forced into the ground so as to take good hold.

Figs. 4 and 5 explain the method of mooring a large ship in a confined situation, where there is not sufficient room for

Bremner's Life Boat.

Fig. 1

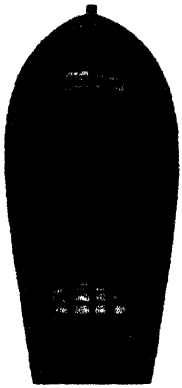
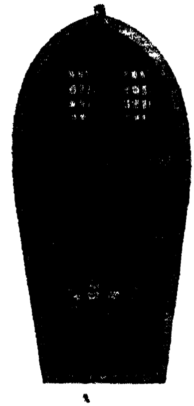


Fig. 2.



Wenmans Mooring Block for Ships

Fig. 3

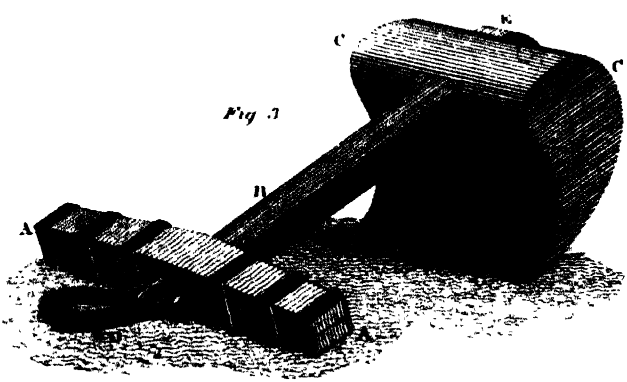


Fig. 4.

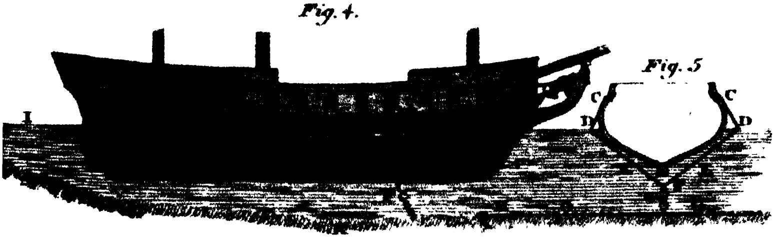


Fig. 5

Published by Henry Fisher Caxton London 1823

her to swing, if the bridles came in at the hawse-holes in the usual manner of mooring.

Near A, fig. 4, is the hawse-hole of the vessel where the bridles of the mooring-chain are generally brought in.

CCC, figs. 4 and 5, are bridles in the improved method.

DDD are wooden bolsters projecting from the ship's sides so far as to keep the two hawsers, EE, clear of the bottom; these hawsers are united in the swivel F, and this, with the mooring-chains GG, which proceed to two blocks, similar to fig. 3, one of which is shown at H, the opposite one does not come within the limits of the plate.

I is supposed to be the line of low water, and K the surface of the ground.

The Maidstone frigate was moored in the manner described above, the bridles coming in at the fourth port from forewards, as shown by the plate; but the plan will answer for ships of all sizes, provided there is a sufficient depth of water under them.

Advantageous Method of gaining Power by ascending a Ladder.

In plate VIII, fig. 1, AA denote parallel ropes, stretched and placed for the purpose of steadily conducting a seat or carriage C, in which a man may sit and descend from the upper to the lower points of AA. These ropes may be placed either in a perpendicular or inclined position; but an inclined position, forming an angle of about twenty degrees with the perpendicular. will in general be found most eligible. The carriage C, may be connected with the ropes, by rings, loops, or any kind of bearing parts which will confine it to a regular ascent and descent. It is connected with the counterpoise or place of re-action, E, by a rope passing over the pulley D. BB represents a ladder for the workmen to ascend.

The manner of working this machine is as follows:—The workman ascends by BB, and places himself in the carriage C, in which his weight (by preference) forms nearly an equilibrium with the weight E, which may, for example, be imagined a basket of coals. In this situation, by a moderate exertion of his arms, either by taking hold of the leading ropes, or of

a rope passing downwards for that purpose, he causes the carriage to descend briskly, which at the same time brings up E. He then quits the carriage, and at that time E (which we may suppose to have been emptied by another assistant, by reversing it or otherwise) being somewhat heavier than C, descends again, and raises C to its first situation; and by the time E is again filled, the workman is ready at the top of the ladder, where he enters the carriage, and raises a second load; and in this manner the work may be continued at pleasure. It is evident that this work may be performed by two or more workmen ascending and descending in succession by means of the same ladder, or, if more convenient, by more ladders than one; and in case it should be desired to lift the body E through a greater space than is to be ascended by the workmen upon BB, the purpose may be effected by fixing D higher, and causing two carriages to descend in succession along the ropes AA, though this plan is not particularly to be recommended. The rope DE may also be wound on a barrel, and the rope DC on another, or smaller barrel, both on the same axis.

The parts of the machine, AA, may, instead of ropes, be wooden or metallic sliders.

This machinery, the Inventor observes, is applicable to drawing, driving, forcing, impressing, or moving bodies of every description; and that in such applications of it, no other variations in the construction, connexion, or method of working it, will be needful, than such as any person possessing an ordinary acquaintance with mechanical operations, may execute with facility.

The vulgar objection to the plan, is, ascending the ladder; yet this is its chief recommendation; for it is the easiest method of raising a weight. The truth of this assertion will be ascertained from the following statement:—

If it be required to raise a sack of corn, a basket of coals, or any other equal weight, to the height of forty feet (more or less) no method can be so easy to the person who is to raise the weight, as to ascend stairs or a ladder, unencumbered, and to raise the sack, &c. by his own weight. By no other exertion of his own, nor by the assistance of any mechanical powers, can he perform the same operation in the same time. It must consequently be the easiest mode of raising a weight, or it could not be done in the shortest time. If it is easier in one operation, it must be equally so in any number of operations. If it is easier for one man, it must be equally so where

any number of men can be employed to work together in raising heavy weights, and where this principle can be introduced. If it is easier, it must be cheaper. The labour consists in ascending the ladder, and in this exertion the man's muscular powers are all in action at the same time, not partially used, as in most other modes of raising weights. His strength may be combined with his gravity in his descent, and is opposed by the least possible friction. He cannot work with greater advantage.

Desaguliers states the maximum of a man's power as under:

1 Man . . . . 500 pounds . . . . 12 feet . . . . 1 minute.

The weight raised was water in a bucket. The man, who was very powerful, ascended stairs with a weight about his own person, which, together with his own, was equal to the water, and placed himself on or in an empty bucket, which was suspended by a rope passing over a pulley, and fastened to the bucket containing the water below, and raised it in the time. The man was so exhausted that he could not repeat the operation.

The following experiment has often been exhibited by the present invention:—

1 Man . . . . 1500 pounds . . . . 12 feet . . . . 1 minute.

And this difference arises from the man's strength being combined with his gravity, and the facilities which the two parallel ropes afford him, to gain velocity by a slight exertion of his arms, to arrest his descent, and quickly to re-ascend the ladder.

If a man weighs 14 stone, or 196 pounds, and ascends the ladder eight times in the minute, (which almost any active man may do,) it is clear that he can raise eight times his own weight, or 1568 pounds.

The steps of the ladder being one foot apart, (that stride being found most agreeable to the labourers,) if a man ascends as slowly as possible, that is, at the rate of one foot in each second, he will ascend five times in the minute to the height of twelve feet; and if he weighs twelve stone, or 168 pounds, (the average weight of a labouring man,) he will raise his weight five times, or 840 pounds, in that time. He will probably consume ten seconds in ascending, and one or two seconds in descending and raising the weight. He cannot

work slower. Applying this rate of work, the result of one man's power, for one hour, in raising the undermentioned articles, will be,

Coals	10 chaldrons	20 feet.
Malt, barley, oats, &c.	90 quarters	20 ,,
Bricks	6000	20 ,,
Water	3000 gallons	20 ,,

When the distance is doubled, the weight raised during the same time, will be one half.

The following weights have already been raised:

		Men.	Feet.	Hours.	Min.
Coals* . . .	240 chaldrons . .	2 . . .	8½ to 21 .	17	7
Bricks† .	22,000	2 . . .	40	7	30
Ditto . . .	6,000	2 . . .	40	1	(
Ditto . . .	1,500	2 . . .	40	0	12

There are four men employed to raise a basket of coals on the river Thames, and six on many parts of the coast. It has hitherto (in 1810) been found impossible to establish or even to try this plan on board of any collier in the river Thames; but it has been used at Brighton, where one of Lathmar's ships was discharge by it, with four men short of the usual complement, and in rather less than the usual time. Only four men being employed to work in the hold, they could not fill the baskets faster, or the vessel would have been discharged in half the usual time. The two men who worked the machine, waited nearly half of the time for a supply, and could have raised twenty chaldrons per hour instead of twelve, the quantity with which they were supplied.

This plan has, for a considerable time, been established at the East India Docks, where all the Indiamen are discharged by it. The first ship on board of which it was tried, was the Fort-William, laden with bales of cotton, weighing about two hundred and three quarters each. The bales were raised by two men only. The Porcher was delivered at the same time, by the old plan, and contained a similar cargo, each bale was raised by six men.

---

* The coals in baskets similar to those used on the river Thames.

† The bricks, two hods, or about thirty-four at a time

From the Fort-William, 5532	bales were delivered in 17 days;		
From the Porcher 5022	„	„	20

Leaving an advantage of four men, three days, and a surplus of 510 bales in favour of the Fort-William. The men who raised the bales on board of the Fort-William stood still nearly half of the time, as the weigher could not pass the bales quicker through the scales. The men who raised the bales from the Porcher were fully employed, and exerted themselves to the utmost, with the hope of preventing the establishment of the new plan.

The Inventor of this machine took out a patent for it, the specification of which is dated March 20, 1809. He offered the use of his invention to the city of London, without the reservation of any remuneration to himself, stipulating only that a part of the saving arising from it might be devoted to a fund for bettering the present and future condition of the men, to whose labours it was chiefly applicable; so as eventually to establish some asylum or provision for them and their families, when age or accident may have disabled them from working. The advantages derivable from the machine were confirmed before C. Flower, the Lord Mayor in 1809, by the affidavits of two men who had used it; by which it appeared that they had actually been able to perform with it more work than had ever been done by any four men in the same time. The Inventor, in his memorial to the Lord Mayor and Court of Aldermen, observes, that any man may work by his plan, no drilling being required, and as it is merely an improvement of the old principle, it should not be regarded as the substitution of any other power for that of man, as steam, horse power, &c.

Tachometer, or Instrument for indicating the Velocity of Machinery.

In the employment of machinery, it is evidently of great importance to be provided with an easy and ready method for discovering at all times whether the motion of the machine is quicker or slower than what is known to be best adapted for the object in view. This advantage may be derived from the

Tachometer, which requires only to be adjusted, once for all to any particular machine, and then it will always be ready, without the help of calculation or of a time-piece, to indicate instantly upon inspection, the slightest excess or defect in the actual velocity.

A front view of the Tachometer is represented by fig. 2, plate VIII, and a side view by fig. 3.

XYZ, fig. 2, is the vertical section of a wooden cup, made of box, which is drawn in elevation at X, fig. 3.

The whiter parts of the section, in fig, 2, represent what is solid, and the dark parts what is hollow.

The cup is filled with mercury up to the level LL, fig. 2. In the mercury is immersed the lower part of the upright glass tube AB, which is filled with coloured spirits of wine, and open at both ends, so that some of the mercury in the cup enters at the lower orifice, and when every thing is at rest, supports a long column of spirits, as represented in the figure. The bottom of the cup is fastened by a screw to a short vertical spindle D, so that when the spindle is whirled round, the cup, the (figure of which is a solid of revolution) revolves at the same time round its axis, which coincides with that of the spindle.

In consequence of this rotation, the mercury in the cup acquires a centrifugal force, by which its particles are thrown outwards, and that with the greater intensity, according as they are more distant from the axis, and according as the angular velocity is greater. Hence, on account of its fluidity, the mercury rises higher and higher as it recedes from the axis, and consequently sinks in the middle of the cup; this elevation at the sides, and consequent depression of the middle, increasing always with the velocity of rotation. Now the mercury in the tube, though it does not revolve with the cup, cannot continue higher than the mercury immediately surrounding it, nor indeed so high, on account of the superincumbent column of spirits. Thus the mercury in the tube will sink, and consequently the spirits also; but as that part of the tube which is within the cup, is much wider than the part above it, the depression of the spirits will be much greater than that of the mercury, being in the same proportion in which the square of the larger diameter exceeds the square of the smaller.

Let us now suppose, that by means of a cord passing round a small pulley F, and the wheel G, or H, or in any other convenient way, the spindle D is connected with the machine whose velocity is to be ascertained. In forming this

connexion, care must be taken to arrange matters, so that when the machine is moving at its quickest rate, the angular velocity of the cup shall not be so great as to depress the spirits below C, into the wider part of the tube. A scale of inches and tenths, as in the figure, must also be applied to AC, the upper and narrower part of the tube, the numeration being carried downwards from zero, which is to be placed at the point to which the column of spirits rises, when the cup is at rest.

Then the instrument will be adjusted, if we mark on the scale the point to which the column of spirits is depressed, when the machine is moving with the velocity required. But, as in many cases, and particularly in steam-engines, there is a continued oscillation of velocity; in those cases we have to note the two points between which the column oscillates, during the most advantageous movement of the machine.

Here it is proper to observe, that the height of the column of spirits will vary with the temperature, when other circumstances are the same. On this account the scale ought to be moveable, so that by slipping it upwards or downwards, the zero may be placed at the point to which the column reaches when the cup is at rest; and thus the instrument may be adjusted to the particular temperature with the utmost facility, and with sufficient precision. The essential parts of the Tachometer have now been mentioned, as well as the method of adjustment; but certain circumstances remain to be stated.

The form of the cup is adapted to render a smaller quantity of mercury sufficient, than what must have been employed either with a cylindrical or hemispherical vessel. In every case, two precautions are necessary to be observed:—First, that when the cup is revolving with its greatest velocity, the mercury in the middle shall not sink so low as to allow any of the spirits in the tube to escape from the lower orifice, and that the mercury, when most distant from the axis, shall not be thrown out of the cup. Secondly, that when the cup is at rest, the mercury shall rise so high above the lower end of the tube, that it may support a column of spirits of the proper length.

Now, in order that the quantity of mercury, consistent with these conditions, may be reduced to its minimum, it is necessary —first, that if MM, fig. 2, is the level of the mercury at the axis, when the cup is revolving with the greatest velocity, the upper part, MMXY, of the cup, should be of such a form as to have the sides covered only with a thin film of the fluid; and secondly, that for the purpose of raising the small quantity of

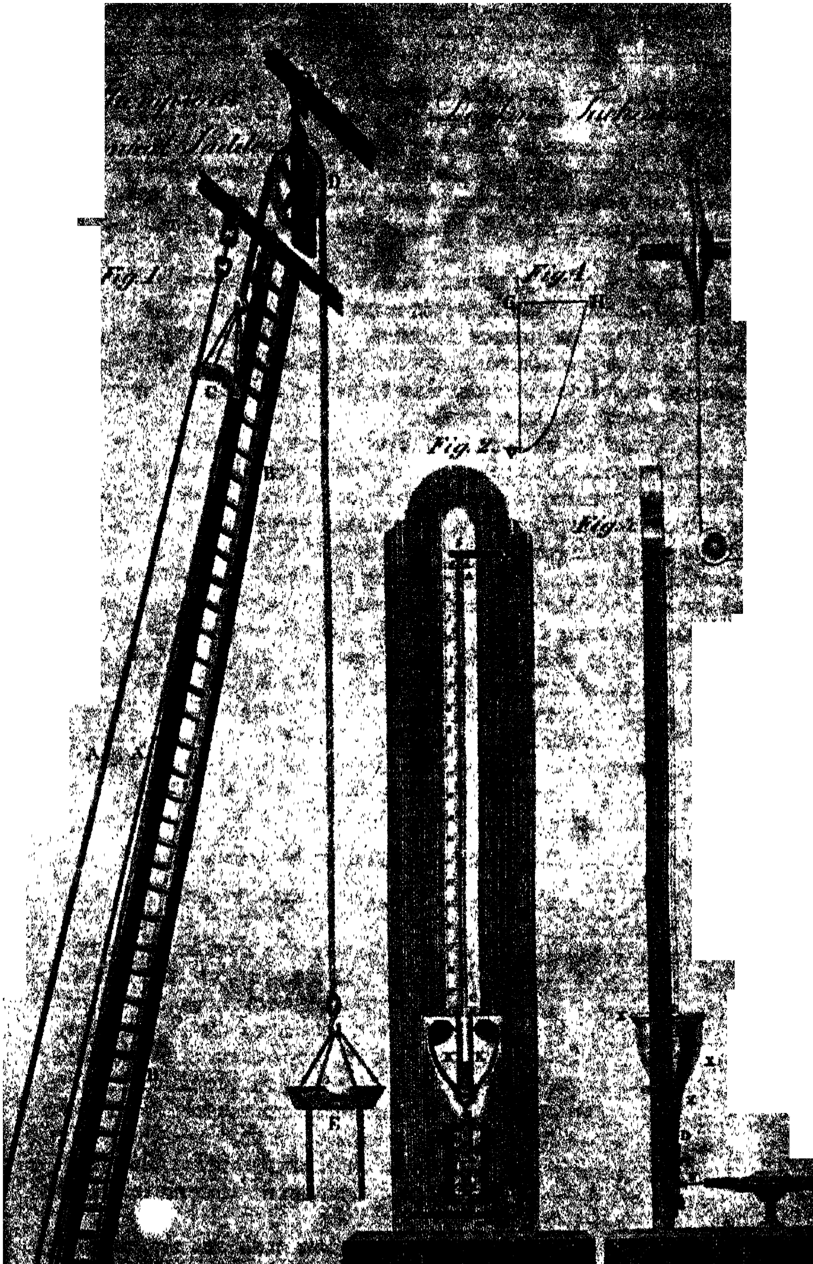
mercury to the level LL, which may support a proper height of spirits when the cup is at rest, the cavity of the cup should be in a great measure occupied by the block KK, having a cylindrical perforation in the middle of it for the immersion of the tube; and leaving sufficient room within and around it, for the mercury to move freely both along the sides of the tube and of the vessel.

The block, KK, is preserved in its proper position in the cup or vessel XYZ, by means of three narrow projecting slips or ribs placed at equal distances round it, and is kept from rising or floating upon the mercury, by two or three small iron or steel pins inserted into the under side of the cover, near the aperture through which the tube passes.

It would be extremely difficult, however, nor is it by any means important, to give the cup the exact form which would reduce the quantity of mercury to its minimum; but we shall have a sufficient approximation, which may be executed with great precision, if the part of the cup above MM is made a parabolic conoid, the vertex of the generating parabola being at that point of the axis to which the mercury sinks at its lowest depression, and the dimensions of the parabola being determined in the following manner:—Let VG, fig. 4, represent the axis of the cup, and V the point to which the mercury sinks at its lowest depression; at any point G above V, draw GH, perpendicular to VG, let n be the number of revolutions which the cup is to perform in 1″ at its quickest motion; let r be the number of inches which a body would describe uniformly in 1″, with the velocity acquired in falling from rest, through a height = to VG, and make $GH = \frac{r}{314\,n}$. Then, the parabola to be determined is that which has v for its vertex, VG for its axis, and GH for its ordinate at G.

The cup has a lid to prevent the mercury from being thrown out of it, an event which would take place with a very moderate velocity of rotation, unless the sides were raised to an inconvenient height; but the lid by obstructing the elevation at the sides of the cup, will diminish the depression in the middle, and consequently the depression of spirits in the tube; on this account, a cavity is formed in the block immediately above the level LL, where the mercury stands when the cup is at rest; and thus a receptacle is given to the fluid, which would otherwise distorb the centrifugal force, and impair the sensibility of the instrument.

It will be observed, that the lower orifice of the tube is


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.

turned upwards. By this means, after the tube has been filled with spirits by suction, and its upper orifice stopped with the finger, it may easily be conveyed to the cup, and immersed in the quicksilver, without any danger of the spirits escaping; a circumstance which it would otherwise be extremely difficult to prevent, since no part of the tube can be made capillary, consistently with that free passage to the fluids, which is essentially necessary to the operation of the instrument.

We have next to attend to the method of putting the Tachometer in motion, whenever we wish to examine the velocity of the machine. The pulley F, which is continually whirling during the motion of the machine, has no connexion whatever with the cup, so long as the lever QR is left to itself. But when this lever is raised, the hollow cone T, which is attached to the pulley, and whirls along with it, is also raised, and embracing a solid cone on the spindle of the cup, communicates the rotation by friction. When our observation is made, we have only to allow the lever to drop by its own weight, and the two cones will be disengaged, and the cup remain at rest.

The lever QR is connected by a vertical rod, to another lever S, having at the extremity S, a valve, which, when the lever QR is raised, and the Tachometer is in motion, is lifted up from the top of the tube, so as to admit the external air upon the depression of the spirits; on the other hand, when the lever QR falls, and the cup is at rest, the valve at S closes the tube, and prevents the spirits from being wasted by evaporation.

It is lastly to be remarked, that both the sensibility and the range of the instrument may be infinitely increased; for, on the one hand, by enlarging the proportion between the diameters of the wide and narrow parts of the tube, we enlarge, in a much higher proportion, the extent of scale corresponding to any given variation of velocity; and on the other hand, by deepening the cup, so as to admit, when it is at rest, a greater height of mercury above the lower end of the tube, we lengthen the column of spirits which the mercury can support, and consequently enlarge the velocity, which, with any given sensibility of the instrument, is requisite to depress the spirits to the bottom of the scale. Hence the Tachometer is capable of being employed in very delicate philosophical experiments, more especially as a scale might be applied to it, indicating equal increments of velocity. But in the present account, it is merely intended to state how it may be adapted to detect in machinery every deviation from the most advantageous movement.

New Method of working Chains, to answer the purposes of Ropes, and Description of a Crane to which it has been applied.

The common iron chain, formed of oval links, from its simplicity of form, and facility of manufacture, has been in use from the earliest ages; and that it did not answer every purpose of a hempen rope, in working over pulleys, was not owing to its peculiar form, but from an error in its application. Every chain of this nature has a twist in itself, arising from a depression given by the hammer, to each link in the welding;* and this circumstance, so trifling in appearance, is not so in its effects, and it has in consequence a perpetual tendency (even when reefed straight in pulleys, and on the barrels of cranes) to assume a spiral form, which a plain cylindrical barrel, and the common pulleys with semicircular grooves, are not in the least calculated to prevent. Hence the alternate links of the chain, in coiling round a barrel, or working over pulleys, form obtuse angles in assuming the spiral form, bearing upon the lower parts of the circumferences, and forming as it were two levers, which wrench open and crush each other in proportion to the weight suspended, as well as prevent the freedom of motion in the links themselves, and thereby load the frame with additional friction.

A still greater obstruction to the uniformity of a chain's motion, in the ordinary method of using it, is the tendency which it has to make a double coil as it approaches the middle of the barrel, and crosses its centre and that of the pulleys at right angles, by means of which the chain is frequently broken by the sudden jerk caused by the upper coil slipping off the undermost.

It is to these causes, that all the accidents which occur to workmen and machinery, from the failure of chains, may be attributed, (bad iron excepted,) and which form the sole objection to their becoming a general substitute for ropes.

As a preventive to these evils, the Author of the present paper, had grooves cast in iron pulleys, of sufficient dimen-

---

* The twist may be seen, by holding a piece of the chain by one end, and viewing the links edgeways as it hangs down.

sions to receive the lower circumferences of the links of the chain, which work vertically; those which work horizontally, and form what may be called the gudgeon part of the chain, bearing upon each side of the grooves.

Barrels of cast iron were also provided, with spiral grooves of the same dimensions, at such a distance from each other as to admit the chain to bed, without the danger of a double coil; by these means the links were retained at right angles with each other, the only position for free and uniform motion.

The links of the chains are made as short as possible, for the purpose of increasing their flexibility, and they are reefed perfectly free from twist, in the pulleys, and on the barrels, for the same reason.

When applied in blocks, the grooves in the pulleys prevent the different falls of the chain from coming in contact, and render plates between them (as in the common way) totally unnecessary; the pulleys are in consequence brought closer together, the angle of the fall from block to block considerably diminished, and the friction against the plates entirely avoided. Brass guards, with grooves opposite to those in the pulleys, are riveted to the blocks, to prevent the chain getting out of its birth from any accidental circumstance. This method of working chains was first put in practice at the iron-works of T. W. and B. Bottfield, near Shiffnal; and employed in the working of cranes capable of purchasing from ten to fifteen tons; in the working of the governor balls of steam-engines constructed by Bolton and Watt, and in the raising of coal and ore from the mines, for which purposes ropes had been before solely used. The chains, in all cases, have performed with the utmost safety, uniformity, and flexibility; so much so, that the prejudices of the workmen against them are entirely done away, and the heaviest articles are hoisted with more ease, and as great confidence of safety as with the best hempen ropes.

The same method is applicable, at a trifling expence, to all machines at present worked by ropes, or by chains in the usual way; and all the common chains now in use, may be applied to it with equal facility.

With a view of ascertaining the relative flexibility of ropes and chains, an iron pulley, thirty-one and a half inches in diameter, was wedged on the spindle of the pinion of a crane answering to this description.

Barrel, 30 inches diameter;
Wheel, 64 teeth;
Pinion, 8 do.;
Top block, with three pulleys of 12 inches diameter;
Bottom block, with two do. do.

To the large pulley was attached a small rope, for the purpose of suspending the weights in the hoisting of the different loads, and the results were as follow:—

The Crane was loaded with	Took to hoist the loads, when reefed with the Chain in grooved pulleys.*	Took to hoist the loads, when reefed with a half-worn, tarred strand-laid rope, 3½ inches in circumference.	Took to hoist the loads, when reefed with the Chain promiscuously, as in the common way
lbs.	lbs.	lbs.	lbs.
First . . 2000	63	74	80
Second . 1000	32	39	41
Third . . 500	17	21	22
TOTAL . 3,500	112	134	143

The flexibility is inversely as these momenta, and proves the superiority of chains; for, on the average of the trials, with the chain in the grooves,

One pound raised . . . . 31.25lbs.
With a half-worn, strand-laid, tarred rope, three inches and a half in circumference 26.11
And with the chain in the usual way, only 24.47

Contrary to the general opinion, it also appears that chains are safer than ropes; for it is an established axiom, that those

* All the experiments were made with the same grooved pulleys.

bodies whose fibres are most in the direction of the strain, are the least liable to be pulled asunder, and in our examination of the properties of a rope, we find that the strands cross the direction of the strain in undulated lines, and consequently prevent its uniform action thereon. A rope is subject to this inconvenience, even when stretched in a direct line, but more particularly so when bent over a pulley, as in that position the upper section moving through a greater space than the under one, is acted upon by the whole strain; and hence the frequent breaking of ropes in bending over pulleys, from the double strain overloading the strands of which the upper section is formed.

The links of a chain are subject to the transverse strain, where they move in contact; but as such strain is in proportion to the length of the bearing, it must be very trifling. All the links having axles of their own, *the chain moves simultaneously with the strain, and both are in consequence retained in continual equilibrio.* A chain in grooves will therefore sustain as great a weight when bent over a pulley, as it will in a direct line, and consequently is safer than a rope.

A safe, uniform, and flexible method of applying chains in the working of machinery, has long been a desideratum in the arts; for they are but little affected by exposure to the weather, or the heat of manufactories, whilst either produces the speedy destruction of ropes.

The discovery is of additional importance, as it substitutes a durable article for a very perishable one, and gives employment to our own manufactories at the expense of foreign importations. The durability is at least six to one in favour of chains.

Though the subjoined description of a crane, is chiefly intended to convey a proper idea of the new method of working chains, yet it will be found to possess several other advantages in point of construction, which are entirely new, and calculated to increase the safety and durability, as well as to lessen the expense, of that useful machine.

On reviewing the principles of a crane, we find that the gudgeons are the points of resistance to the machine and its load, and consequently the effect of the tranverse strain upon the perpendicular, will be in proportion to the distance of the mortise for the jib from the upper one; and that of the oblique strain, in proportion to the distance of the mortise for the diagonal stay, from the lower one.

Notwithstanding these circumstances are so evident, they are seldom attended to; for in general a large and expensive piece of oak, sufficient of itself to make a crane of double the purchase, forms the perpendicular; the jib is mortised into it, at eighteen or twenty inches from the top, to make room for the gudgeon, as is the diagonal stay, at five or six feet from the bottom, to allow a birth below for the barrel. Thus the effect of the transverse and oblique strains of the jib and diagonal stay upon the perpendicular, is increased by their distances from the gudgeons, or points of resistance, and the perpendicular itself considerably weakened by mortises made where the greatest strength is required. Hence the frequent failure of cranes, of the common construction, by the breaking of the perpendiculars in the mortises.

It appears, however, that the various parts of a crane formed of wood, cannot be connected together in any other way than by mortising; and as this method considerably diminishes the strength of the timber, it is better to depend on cast-iron mortise-pieces.

The perpendicular of the crane to which the new mode of working chains has been applied, is formed of two oak planks, each eighteen inches wide, four thick, and sixteen feet long; these, at the top and bottom, are let into cast-iron mortise-pieces, which retain the planks ten inches asunder. The barrel for the chain works between them. The piece at the top contains in the middle a dove-tailed mortise, into which a stock for the jib is fixed; for greater security, an iron bolt goes through the whole; the stock projects two feet from the mortise, and a plank eighteen inches deep, and four thick, is bolted to each side of it to form the jib, the interstice between the planks forming a birth for the top block to slide in. The diagonal stay is of the same dimensions, formed in a similar manner, and connected to the perpendicular, by being let into the lower mortise-piece.

In this mode of construction, scarcely any part of the timber is cut away; and the strength of the materials, so far from being diminished, is augmented by the cast-iron mortise-pieces; the jib is brought much closer to the upper gudgeon, and the centre lines of the perpendicular and the diagonal stay crossing each other at the top of the lower one, places the whole strain as nearly as possible in a line with the gudgeons. The business of the perpendicular becomes, in consequence, little more than that of a mere prop, and consequently requires no greater strength of materials than the diagonal stay.

The top block is made of cast-iron, and has a groove three inches deep on each side, for the purpose of embracing the planks which form the jib.

To prevent the inconvenience of the dirt of the floor getting into the brass of the lower gudgeon, and thereby obstructing the revolution of the crane, those parts are the reverse of the common way,—the gudgeon being fixed in the floor, and the socket part which embraces it is cast in the bottom of the mortise-piece, as is also a channel to convey oil to the gudgeon.

Fig. 1, plate IX, represents the crane with all its parts complete, ready for work.

AB, the perpendicular, formed of two oaken planks, each eighteen inches wide, four thick, and sixteen feet long, let into cast-iron mortise-pieces, CD.

EE, the barrel for the chain which works between the two planks of the perpendicular.

F, the top piece, containing in the middle a dove-tailed mortise, into which H, a stock for the jib, is fixed: an iron bolt goes through the whole for greater security. The stock projects two feet from the mortise, and two planks, IK, eighteen inches deep, and four thick, are bolted one on each side of it, to form the jib, the interstices between these planks forming a birth or space for the top block L to slide in. This block is made of cast-iron, and has a groove three inches deep on each side.

M, the diagonal stay, is of the same dimensions as the jib, formed in a similar manner, and connected to the perpendicular, by being let into the lower mortise-piece D.

N, the handle or winch, turns a small pinion O, fixed on the same axis; this pinion works in the teeth of the wheel P, moving on the same axle as the barrel E, on which the chain R lies in the spiral grooves.

S, the block and hook by which goods are raised.

Fig. 2, is a side view of the handle N, the pinion O, the toothed wheel, and the barrel E placed between the two uprights AB.

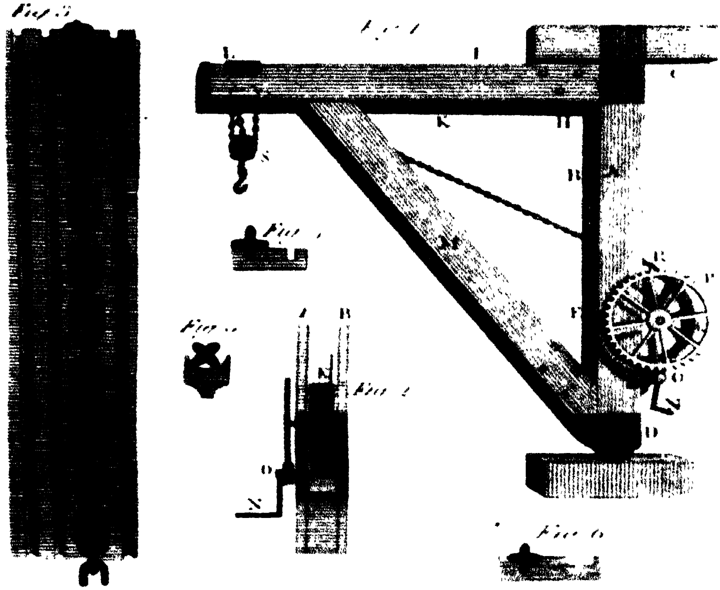
Fig. 3, shows, upon an enlarged scale, part of the barrel E, and some of the chain lying in its proper position in one of the spiral grooves or channels: it is to be noted that the lower edge of one link lies in the groove, and the next link upon the surface of the barrel, and that by this means the chain is prevented from twisting, in winding upon the barrel.

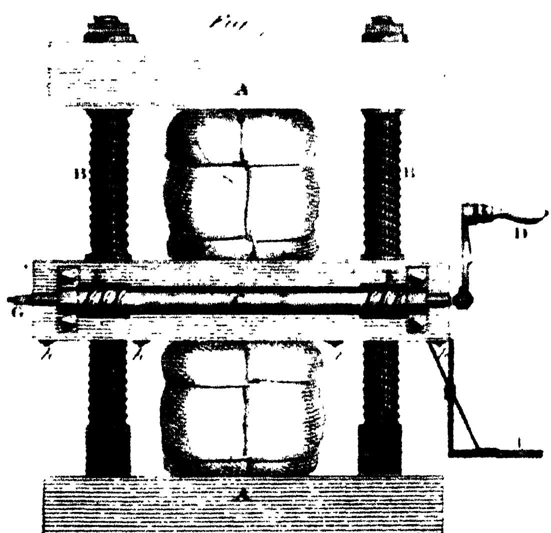
Fig. 4, shows a section of part of the barrel E, in order to point out clearly the manner in which one link lies within it, the other link being on its outside; it is constrasted by fig. 5, the old method of working the chains.

After an ample trial of the method of working chains as above described, its utility has been fully confirmed; but experience suggested to the Inventor of the plan, an improvement which renders nothing more to be wished as a substitute for the expensive article of ropes. A small degree of brightness was observed upon those links which worked vertically; this brightness was evidently caused by the angle in which the other worked from block to block, producing side friction in the grooves of the pulleys. A concave rim on each side, to embrace the links which worked flat, and thereby prevent those which worked vertically from coming into contact with the sides of the grooves, was therefore thought of. This last contrivance of providing a bed for both sorts of links, will be fully understood by fig. 6, especially when it is compared with fig. 4. The importance of this further improvement will easily be appreciated, by comparing the following table with the one already given. The experiments in both cases were tried with the same crane:

The Crane was loaded with	Took to hoist the loads, when reefed with the Chain in improved grooved pulleys,
First . . . 2000 lbs.	58 lbs.
Second . . . 1000 ,,	30 ,,
Third . . . . 500 ,,	16 ,,
TOTAL . . 3500	104 lbs.

So that on the average of the trials, one pound raised 33.65 pounds, and consequently, this crane works 7.68 per cent. more flexibly with a chain reefed in the *improved* grooved





pulleys than with the original ones; 28.87 per cent. more flexibly than with a half-worn, strand-laid, tarred rope, of three and a half inches in circumference; and 37.51 per cent. more flexibly than with the same chain used promiscuously, as in the common way.

Improvement of the Machinery for raising Coals, Ore, or other articles from Mines.

This invention consists in the application of the mode of working chains detailed in the preceding paper, along with a rectified form of the barrel for the reception of a considerable length of chain. It is by the same ingenious person as the last invention, and is undoubtedly susceptible of adaptation to a variety of important machinery, as well as to the valuable purpose which forms the leading object before us.

The machines in general use for using coal and ore from the mines, are (from the increased expense of horse-labour) worked by a steam-engine, attached to a crank of twenty-one inches radius, wedged on a shaft along with a fly-wheel, eleven or twelve feet in diameter, and pinion-wheel of eleven teeth, which latter works in another of sixty-four teeth, on the shaft of which is a plain cylindrical barrel, from four to six feet diameter, and nine or ten feet long; some have barrels formed of frustums of cones, (whose perimeters are in the proportion of about five to four,) united at their bases, and of various diameters; the axes of both kinds are placed at right angles with the centre line of the pit, and at each end a rope of six inches in circumference is made fast by a staple, which ropes work (in contrary directions at the same time) over two pulleys, placed in frame parallel to each other, and at an equal distance from the centre of the pit; to the ends of these ropes the baskets of coal and ore to be raised are hooked. The simplicity of their general structure is such as, perhaps, not to admit of any considerable improvement; but the forms of the barrels are very defective.

On putting one of these machines in motion, each rope forms a triangle; lines from the pulley to the first and last coil, and the surface of the barrel, forming its three sides. Upon the cylindrical barrel, the load always tends, from gravitation,

towards the nearest point of contact with the centre of motion of the barrel, and, in consequence, the ascending rope at first bends around it in receding coils from the subtending side of the angle, diminishing their distances as they approach the nearest point of contact, (where the rope crosses the centres of the pulley and barrel at right angles,) thereby leaving a great part of the barrel uncovered by the rope, and hence the necessity of such long ones; afterwards coiling hard against itself as it approaches the other side of the triangle, to its great injury in wear.

The barrels formed of frustums of cones, united at their bases, whose perimeters are in the proportion of about five to four, are equally defective, on account of the rope, for the reason before mentioned, binding hard against itself, and even sometimes (in wet weather, when its rigidity is increased by the absorption of water) folding at first in receding coils, and afterwards so hard against itself as to force those receding coils to slip suddenly towards the small perimeter of the cone, thereby making a large portion of the rope to descend the pit in an instant, breaking the rope by the sudden jerk, and frequently causing the immediate destruction of the men who may be ascending the pit at the time, or dashing to pieces the basket and its contents.

Besides the unnecessary expense arising from the use of hempen ropes, and the breaking of chains when applied in the common way, the forms of the barrels are quite erroneous in principle. Some are cylindrical; others formed of frustums of cones united at their bases, without any determinate proportion in their perimeters, or regard to the weight of the rope or chain working thereon, both of which are absolutely necessary to acquire a maximum effect.

The convex surface of a frustum of a cone, is = to the convex surface of a cylinder of the same altitude, having its circumference = to half the sum of the perimeters of the frustum; and circumferences of circles being to one another as their diameters, the surface of a barrel formed of two frustums of right cones, (united at their bases), each 64 inches in diameter at one end, 32 at the other, and 54 long, (which is a size that will often be required,) is = to the surface of a plain cylindrical one, 48 inches in diameter, and 108 long. Each will therefore bend the same length of cordage in an equal number of revolutions, and so far they are equal to each other; but they vary very considerably in the momenta required to work them.

Let a = the weight of the basket of coal, and b = that of the descending part of the chain; then, on the cylindrical barrel, when the former is hooked to the end of the latter, and eased from the bottom of the pit, (the opposite chain being bent on the barrel,) $a+b$ = the counterpoise required at 24 inches radius; and when it is wound up to the top, (the descending part of the opposite chain hanging down the pit,) $a—b$=the counterpoise required at the same radius.

On the barrel formed of frustums of right cones, when the load is eased from the bottom of the pit, it and the chain are suspended from one of the smaller perimeters, (the opposite chain being bent on the barrel,) $\frac{a}{2}+\frac{b}{2}$ = the counterpoise required at 32 inches radius; and when it is wound to the top of the pit, it is suspended from the larger perimeter of one frustum, whilst the descending part of the opposite chain is hanging down the pit from the smaller perimeter of the other, and in that position $a—\frac{b}{2}$ = the counterpoise required at the same radius.

Consequently, by supposing a, the weight of the basket of coal, to be 800 pounds, and b, the weight of the descending part of the chain, 400 pounds, we have the counterpoise required upon the cylindrical barrel, at 24 inches radius, 1200 pounds, when the basket of coal is at the bottom of the pit, and 400 pounds when it is at the top; but upon the barrel formed of frustums of right cones, the counterpoise required at 32 inches radius is 600 pounds in each position. And as the counterpoise required is in an inverse proportion to the length of the radius at which it is applied, we have 24 : 32 : : 600 : 800 pounds, the counterpoise required upon the barrel formed of frustums of right cones, at 24 inches radius. Again, as the descending part of a chain + a basket of coal of double its weight, unbending out of equidistant grooves from the base of a frustum of a right cone, towards its smaller perimeter, balances, in every revolution of the barrel, a chain of equal weight + a basket of coal, of double its weight, bending into equidistant grooves from the smaller perimeter of a similar frustum towards its base, the counterpoise required must be equal in all parts of the descent.

Hence, by making the weight of the basket of coal to that of the chain, and the perimeters of the frustums of cones, which form the barrel, to each other, in the proportion of two to one, *a maximum is obtained, by whirh a barrel of this description requires one-third less momentum (and consequently one-third less expense) to work it than a cylindrical one.*

The barrels are made by nailing two to three inch planks upon wooden or iron curves as in the common way, and afterwards folded spirally, with wrought-iron tire, so as to leave a vacancy of about half an inch between each fold, for the lower part of the ellipsis of those links of the chain which work vertically to move in, and keep the coils at an equal distance from each other.

The wrought-iron tire is of two kinds, the one for conical, and the other for cylindrical barrels; the cross section of the former is nearly a parallelogram, one inch and a quarter by $\frac{5}{8}$ths of an inch, out of the upper part of which about one-fourth of an ellipsis is taken, to form a horizontal bearing for those links of the chain which lie flat upon the tire: the cross section of the latter is a rectangle, one inch and a quarter by half an inch. Both are rolled into their proper form, and holes of a quarter of an inch diameter punched therein, at a foot from each other, for the purpose of nailing them to the planking of the barrels.

Although the method of working chains in grooves had been in use three years and a half at the time this paper was drawn up, (1807,) and T. W. and B. Bottfield had nearly three thousand feet in daily motion at their manufactory, yet not a single link had broken, or the least accident occurred therefrom. The wear was so trifling, that it appeared the chains would sooner fail from oxidation than attrition, for although the machines for raising coal and ore from the mines are in use twelve hours in the day, the brown oxide of iron formed upon the links by exposure to the atmosphere, is seldom disturbed by the motion of the chain. It is probable, therefore, that, in this manner of working, chains will last at least fifteen years; but to be certain, it is taken at twelve in the subjoined comparative statements, which show that the expense of chains as cordage is not a fourteenth part of that of hempen ropes. And in this statement, the superiority of chains is so far from being over-rated, that there is every probability the expense of them will be less than the twenty-fourth part of that of hempen ropes.

The method of folding wooden barrels with wrought-iron tire, does away the necessity of cast-iron ones, and may be applied to every wooden barrel now in use at a small expense, as may be seen by the estimate which is subjoined.

STATEMENT OF THE EXPENSE OF TARRED ROPES FOR A MACHINE FOR RAISING COAL AND ORE FROM A PIT EIGHTY YARDS DEEP, FOR THREE YEARS AND FOUR MONTHS.

	£	s	d
Ten ropes, each 110 yards long, 6 inches in circumference, and 5 lbs. per yard, 5500 lbs. at 8d per lb.	£183	6s	8d
Deduct 10 worn-out ropes, 2750 lbs. at 1d. per lb. .	11	9	2
Expense of ropes for 3 years and 4 months	£171	17	6

EXPENSE OF CHAINS FOR THE SAME MACHINE, AND FOR THE SAME TIME.

	£	s	d
Two chains, each 110 yards long, formed of ⅜th inch iron, 28 links to the yard, and weighing 5 lbs. per yard, 1100 lbs. at 6d per lb. . . .	£27	10s	0d
180 yards of wrought-iron tire, with the holes punched therein, weighing 7 lbs. per yard, at 1s 6d per yard	13	10	0
540 nails for the tire, 27 lbs. at 6d per lb.	0	13	6
Workmanship, nailing the tire on the barrel, 180 yards, at 2½d per yard	1	17	6
	£43	11	0

The above chains, at the end of the three years and four months, did not appear to be one-fourth worn.

Plate X, represents the machine to which the rectified barrels, and new mode of working chains, has been applied.

Fig. 1, *a*, a crank to which the connecting-rod is fixed, to attach the machine to the steam-engine which works it.

b, a wheel of 13 teeth, wedged upon the same shaft with the crank, and which works into the wheel *d*.

c, a fly-wheel eleven feet in diameter, wedged upon the same shaft as the wheel *b*.

d, a wheel of 64 teeth, wedged upon the same shaft as the barrel, and into which the wheel *b* works.

e, a wooden barrel, formed of two frustums of cones united base to base, and folded spirally with wrought-iron tire,

which keeps the links of the chains at right angles with each other, and with the grooves in the pulleys.

f f, the reeling post and its lever, for disengaging the barrel from the steam-engine, when the men are to be let down into the pit by means of the break.

g g, a break wheel, break and lever, for regulating the velocity of the barrel when disengaged from the steam-engine, and in the act of lowering the miners into the pit.

h h, the frame on which the machine is erected.

Fig. 2, *i i*, the pit frame, for supporting the pulleys.

k, the pit represented by a circle, part of which is shown open, and part by dotted lines.

l l, two grooved pulleys, over which the chains, extending a considerable length from the barrel *e*, work in parallel lines.

m, the carriage (called a tacking in Shropshire) on which the coal and ore are landed from the chain at the pit head, moving on four small iron wheels.

n n, baskets in which the coal and ore are raised from the pits.

o, the hook which goes into the staple of the basket to draw it forward when lowering on to the tacking.

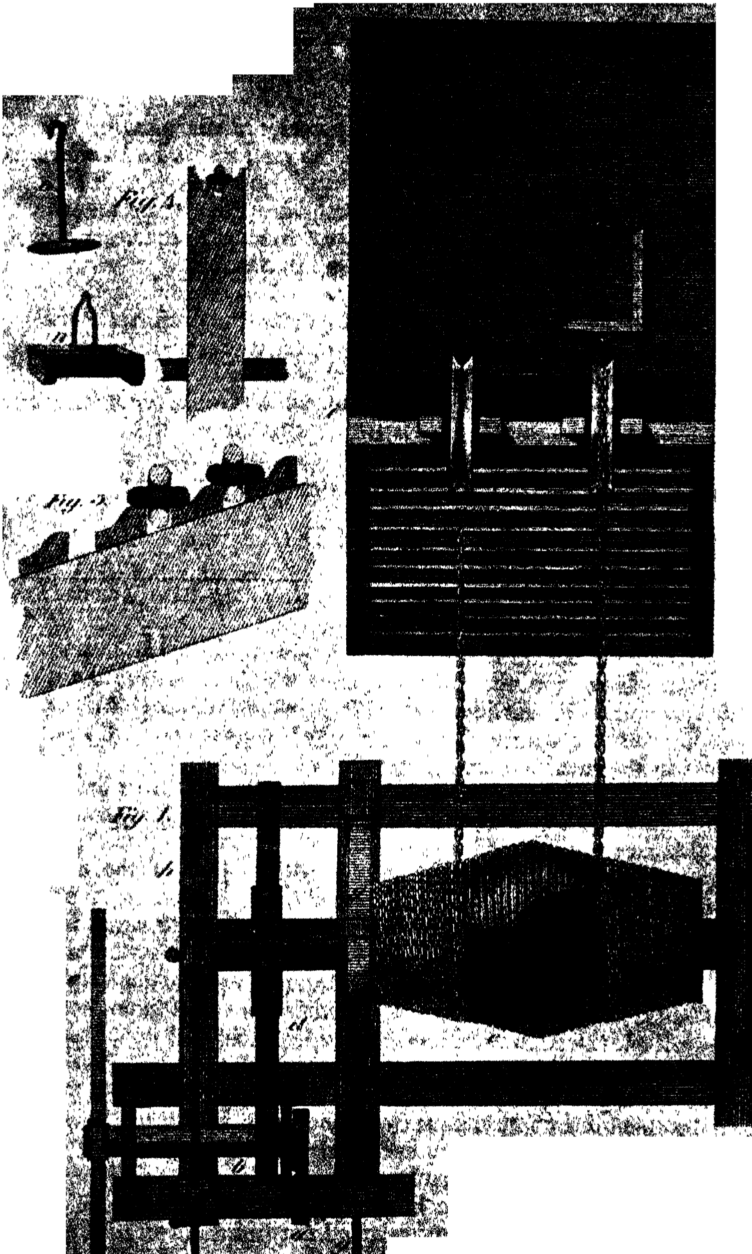
After the basket is lowered, the tacking is drawn forward by two girls to the edge of the frame, which is laid level with the ground on its outside, and near to which the coal and ore are loaded into waggons, and afterwards drawn upon iron railways to the furnaces, forges, &c.

Fig. 3, a section of a part of the barrel and tire, showing the manner in which the links of the chain lie on it, on a scale of 3 inches to the foot.

Fig. 4, a section of the pulley, with a link of the chain lying in it.

In a large machine, the barrel is fixed 24 or 25 yards from the pit.

Great and obvious as are the advantages, and particularly the security, derived from the use of chains, in the manner above described, the colliers, immersed in ignorance, and unwilling to admit that any thing was good which they had not seen practised from their youth, required ropes even for one of them at a time, to let them down into the pit in the morning, and draw them up at night, though all the other work of hoisting through the day was securely performed by chains; but it was very apparent how perversely they were biassed by prejudice, as, to attend any kind of diverson, they hesitated not to be drawn up by the chain two or three together.



Preparation of cheap and durable Paints with Fish Oil.

The art of rendering fish-oil a proper vehicle for paints, is but little known, though a few individuals have derived from the knowledge of it considerable emolument and credit; for fish-oil paints, when properly managed, are not only cheaper than any other kind of oil paints, but equal to any in beauty, not subject to blister or peel off by the sun, and remarkable for durability. The following statement will show the advantages, in point of expense, attending the process now to be proposed:

COST OF REFINING ONE TUN OF COD, WHALE, OR SEAL OIL.

	£	s	d
One tun of fish-oil, or 252 gallons.	£36	0s	0d
32 gallons of vinegar, at 2s per gallon	3	4	0
12 lbs. litharge, at 5d per lb.	0	5	0
12 lbs. white copperas, at 6d do.	0	6	0
12 gallnos of linseed oil, at 4s 6d per gallon	2	14	0
2 gallons of spirits of turpentine, at 8s do.	0	16	0
	£43	5	0

252 gallons of fish-oil,
12 do. linseed oil,
2 do. spirits of turpentine,
32 do. vinegar.

	£	s	d
298 gals. being worth 4s 6d per gal. will produce	£67	1s	0d
Deduct the expense.	43	5	0
Profit	£23	16	0

TO PREPARE FISH-OIL.

Into a cask which will contain about forty gallons, put thirty-two gallons of good common vinegar; add to this twelve pounds of litharge, and twelve pounds of white copperas in powder; bung up the vessel, and shake and roll it well twice

a day for a week; when it will be fit to put into a tun of whale, cod, or seal oil; (but the Southern whale-oil is to be preferred, on account of its good colour, and little or no smell;) shake and mix all together, when it may settle until the next day; then pour off the clear part, which will be about seven-eighths of the whole. To this clear part add twelve gallons of linseed-oil, and two gallons of spirits of turpentine; shake them well together, and after the whole has settled two or three days, it will be fit to grind white lead and all fine colours in; and, when ground, the paint cannot be distinguished from those ground in linseed-oil, unless by the superiority of its colour.

If the oil is wanted only for coarse purposes, the linseed-oil and spirits of turpentine may be added at the same time that the prepared vinegar is put in; and, after being well shaken up, it is fit for immediate use without being suffered to settle.

The vinegar is to dissolve the litharge, and the copperas accelerates the dissolution, and strengthens the drying quality.

The residue, or bottom, when settled, by the addition of half its quantity of fresh lime-water, forms an excellent oil for mixing with all the coarse paints for preserving outside work. When prepared with lime-water, it will be hereafter, in this paper, called *incorporated oil*.

Note. All colours ground in the above oil, and used for inside work, must be thinned with linseed-oil and spirits of turpentine.

PREPARATION AND EXPENSE OF VARIOUS IMPENETRABLE PAINTS.

SUBDUED GREEN.

	£	s	d
Fresh lime-water, 6 gallons	£0	0s	3d
Road dirt, finely sifted, 112 lbs.	0	1	0
Whiting, 112 lbs.	0	2	4
Blue black, 10 lbs.	0	2	6
Wet blue, 20 lbs.	0	10	0
Residue of the oil, 3 gallons	0	6	0
Yellow ochre in powder, 24 lbs.	0	2	0
	£1	4	1

This composition will weigh 368 pounds, and the cost of it will therefore not be one penny per pound. To render it fit for use, to every eight pounds, add one quart of the incorporated oil, and one quart of linseed-oil, and it will be found a paint with every requisite quality, both of beauty, durability, and cheapness; and in this prepared state, the cost of it does not exceed 2½d per lb. whereas the coal tar of the same colour is sixpence.

In preparing this subdued green, first pour the six gallons of lime-water into a large tub, then throw in 112 pounds of whiting; stir it round well; let it settle for about half an hour, and stir it again. Now put in 112 pounds of road dirt, mix it well, then add the blue black, after which the yellow ochre, and when all is tolerably blended, take it out of the tub, and put it on a large board or platform, and with a labourer's shovel, mix and work it about after the manner in which mortar is prepared. Now add the wet blue, which must be previously ground in the incorporated oil (as it will not grind or mix with any other oil.) When this is added to the mass, begin to thin the whole with the incorporated oil, in the proportion of one quart to every eight pounds, and then the linseed-oil in the same proportion, and it is ready to be put into casks for use.

LEAD COLOUR.

	£	s	d
Whiting, 112 lbs.	£0	2*s*	4*d*
Blue black, 5 lbs.	0	1	3
Lead ground in oil, 28 lbs.	0	14	0
Road dirt, 56 lbs.	0	0	6
Lime-water, 5 gallons	0	0	6
Residue of the oil, 2½ gallons	0	5	0
	£1	3	7

The weight of this composition will be 256 pounds. When two gallons of the incorporated oil, and two gallons of linseed-oil, have been added to it, to thin it for use, it will not exceed 1¾d per pound.

The lime-water, whiting, road dirt, and blue black, must be first mixed together, then add the ground lead, first blending

it with two gallons and a half of the prepared fish-oil, after which, thin the whole with the two gallons of linseed-oil and two gallons of incorporated oil, and it will be fit for use. For garden-doors, and other work liable to be in constant use, a little spirits of turpentine may be added to the paint with advantage, when it is laid on.

BRIGHT GREEN.

	£	s	d
112 lbs. yellow ochre, in powder, at 2d per lb.	£0	18s	8d
168 do. road dust	0	1	8
112 do. wet blue, at 6d. per lb.	2	16	0
10 do. blue black, at 3d per lb.	0	2	6
6 gallons of lime-water	0	0	6
4 do. fish-oil, prepared	0	12	0
7½ do. incorporated oil	0	15	0
7½ do. linseed-oil, at 4s 6d per gallon	1	13	9
592 lbs. weight.	£7	0	1

This bright green does not exceed 3¼d per pound, when ready for laying on, and yet is equal in quality to any green, which, in the common mode of preparing the colour, can be afforded for 1s 6d per pound.

After painting, the colour left in the pot may be covered with water to prevent it from skinning; and the brushes, as usual, should be cleaned with the painting knife, and kept under water.

A still brighter green may be formed by omitting the blue black; a lighter green may be made by the addition of ten pounds of ground white lead; and by varying the proportions of the blue and the yellow, various shades of green will of course be obtained.

Observe, that the wet blue must be ground with the incorporated oil, previous to its being mixed with the other ingredients.

STONE COLOUR.

	£	s	d
4 gallons of lime-water	£0	0s	4d
112 lbs. whiting	0	2	4
28 do. ground white lead, at 6d per lb.	0	14	0
56 do. road dust	0	0	6
2 gallons prepared fish-oil	0	6	0
3½ do. incorporated oil	0	7	0
3½ do. linseed-oil	0	15	9
293 lbs. weight.	£2	5	11

The above stone-colour, fit for use, is not 2d per pound.

BROWN RED.

	£	s	d
8 gallons lime-water	£0	0s	8d
112 lbs. Spanish brown	1	0	0
224 do. road dust	0	2	0
4 gallons of fish-oil	0	12	0
4 do. incorporated oil	0	8	0
4 do. linseed-oil	0	18	0
501 lbs. weight.	£3	0	8

This composition forms an excellent brown red, at the rate of not quite 1½ per pound. The Spanish brown must be in powder.

A good chocolate colour is made by the addition of blue black in powder, or lamp black, till the effect desired is obtained; and a lighter brown may be formed by adding ground lead. By ground lead, is meant white lead ground in oil.

Yellow paint is prepared with yellow ochre in powder, in the same proportion as the Spanish brown.

Black is also prepared in the same proportion, using lamp black or blue black.

It appears from experiments, that fine sand will not answer the purposes of road dirt in painting; it is the dry dirt or dust

collected in highways much travelled by horses and carriages, and afterwards finely sifted, which is the article recommended, as possessing the properties required.

Though various compositions have been adopted, to render oil unnecessary, as an ingredient in ornamental and preservative coverings for wood, iron, &c. yet none has been discovered, which, for general use, is comparable to those prepared with oil, nor does there seem reason to hope that the object can be accomplished without a large proportion of this vehicle. It is therefore particularly desirable to render oil-paints as cheap as possible, and the preceding details will have rendered it evident, how well the processes now given, accomplish this end: the highest price of any of the paints does not exceed threepence farthing per pound, when in a state fit for use, and though variations in the prices of some of the articles may render a revision of the calculations proper, yet the alleged advantages will still remain nearly in the ratio stated.

These fish-oil paints have a strong body, and require no particular skill in laying on, any common labourer being adequate to the work.

Method of whitening Linseed Oil.

Take any quantity of linseed-oil, and to every gallon add two ounces of litharge; shake it up every day for fourteen days, then let it settle a day or two; pour off the clear part into shallow pans, the same as dripping-pans, first putting half a pint of spirits of turpentine to each gallon. Place it in the sun, and in three days it will be as white as nut-oil.

This oil, before it is bleached, and without the turpentine, is far superior to the best boiled oil, there being no waste or offensive smell.

Preparation of White Paint for inside work.

To one gallon of spirits of turpentine, add two pounds of frankincense; let these ingredients simmer over a clear fire until the resin is dissolved; strain the solution, and bottle it for use. To one gallon of bleached linseed-oil, prepared as in the last article, add one quart of the above, shake the mixture well, and bottle it also. Let any quantity of white lead be ground with spirits of turpentine very fine, then add a

sufficient portion of this mixture to it, until it is in a suitable state to lay on. If in working it grows thick, it must be thinned with spirits of turpentine.

This paint is a flat or dead white, and though not divested of smell at the moment it is used, yet in four hours it will become dry, and all smell will in that time be gone. It is remarkably constant, retaining its whiteness though exposed to all weathers.

Description of a Double Press, for packing Goods.

A front elevation of this press, which is particularly convenient for packing goods, is represented by fig. 7, plate IX.

AA, the frame of the press.

BB, the large screws, which, in this press, contrary to those in common use, at all times remain stationary.

C, a cylindrical iron bar, extending beyond the sides of the press, and having thereon two worms or endless screws.

EE, the endless screws, which work in two toothed wheels, fixed to the nuts; by turning the winch D, the nuts and bed are driven up and down the screws, as may be found necessary.

F, a stage suspended from the bed, and on which the men stand who work the press; such a stage may, if found necessary, be fixed at the other end of the bar, another winch being put upon the square shoulder G.

The bed of the press must be formed of two pieces of strong wood, which are held together by screws and nuts, as shown at *h h h h*.

One very considerable advantage of this press is, that much time is saved by its being a double press; for it will very readily be perceived, that when the lower package has been sufficiently pressed, as the bed or presser is raised, (another package being thereon,) the upper package begins to be pressed, as the one underneath is relieved, and so alternately, during the whole operation.

Machines for equalizing the Width and Thickness of Leather Straps.

The thickness and width of leather straps cannot be correctly regulated by handwork; yet in proportion to the degree in which these two properties are obtained, the utility of the straps is increased, because they admit of an equal tension in every part. A method, therefore, for the perfect equalization of the thickness and width of leather straps, is of considerable importance in the arts, and the following machines, taken together, have been found completely to effect these purposes.

Figures 1, 2, and 3, plate XI, are a plan, section, and end view of the instrument for cutting leather straps to an equal thickness.

A, is the knife fixed to the frame by two screws *a a*, which pass through holes in the end of the knife, and have two nuts upon each of them, between which is fastened the knife, and by means of these the knife can be raised or lowered, and fixed at any point, by screwing the nuts towards each other: *b*, fig. 3, is the lower, and *c* the upper one, which fastens the knife upon the other.

The screws, *a a*, are fastened to the frame by two plates and four screws at *d d d d*, which fit into oblong holes in the plates, and can be loosened to put the knife nearer to, or further from a roller B, between which, and another roller D, fig. 2, (concealed in the wooden frame,) the leather strap passes.

The bearings *e e*, for the pivots of the upper roller, are screws, and received into tubes, EE, figs. 2 and 3, which are also screwed internally, so that, by turning these tubes round, the roller is brought nearer to, or further from the roller D, to suit straps of different thicknesses; the tubes are also drawn down by helical springs (concealed in the wood) which keep the upper roller down with a moderate pressure, but at the same time allow it to rise up, if a thick part of the strap comes under it.

FF, are two handles fixed to the mahogany block, which is the frame for the whole.

G, is a rod or wire bent at right-angles at each end, and driven into the block, with two sliding pieces, *g g*, upon it,

Aubrey's Instruments for equalizing Leather Straps.

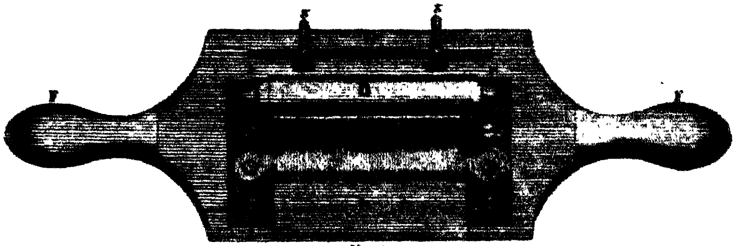
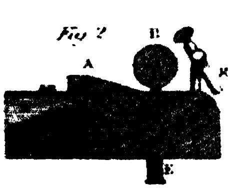
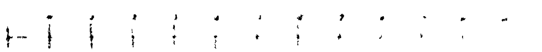


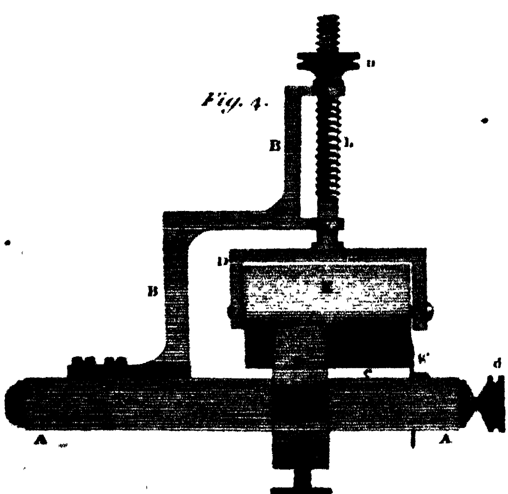
Fig. 1

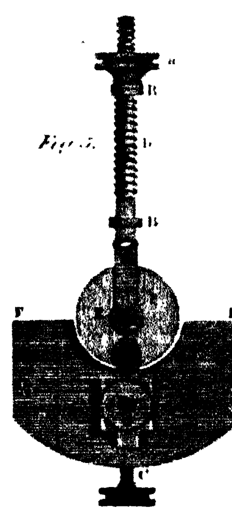






Scale of Inches.







Inches.

which can be fixed at any distance from each other by screws; these are set to the width of the strap, to keep it parallel in passing through the rollers B and D; it enters in between them, passing under the knife A, and over the inclined part *h*, fig. 2; the end which is just through, is fastened to the work-bench, and the workman takes the machine by its handles FF, and draws it back from the bench, this pulls the strap through between the rollers, and the knife removes all the leather which projects above its edge, leaving the strap of a perfectly equal thickness throughout. This thickness is, as above mentioned, regulated by the distance the knife-edge is placed above the roller D: in cutting the strap, the smoothest side is placed downward upon the lower roller.

Figures 4 and 5, are elevations of the machine for cutting the strap to an equal width throughout.

AA, is a brass bar, made hollow for lightness.

BB, an iron frame screwed to it, and supporting a frame D, containing a roller E.

The frame D slides up and down in the other by a screw and nut *a*; but it has a constant tendency towards the bar A, by means of a spring *b*, which surrounds the screw, and counteracts the pressure of the nut *a*.

F is a piece of brass sliding upon the bar A, and can be fixed at any part of it by the screw C. It has a semi-circular gap cut in it, to admit the roller E, as shown in fig. 5.

A small and thin sharp-edged knife *g*, is put through the end of the bar A, and held in its place by a screw *d*; this knife is placed exactly at the end of the roller, as seen in fig. 4.

The strap to be cut, is passed through the opening *e*, fig. 4, and the roller suffered to descend by its nut *a*, until the spring presses the roller down upon the strap with sufficient force to keep it steady; the piece F is fixed along the bar, at the same distance from the knife as the strap is intended to be wide, and this is shown by the divisions on the bar; the strap being then drawn through, under the roller, the knife cuts away all parts which are beyond its edge, and reduces the strap to the proper breadth.

New Mode of manufacturing Muffles, for chemical purposes.

The usual method of manufacturing chemical muffles, by means of wooden moulds, is liable to many inconveniences, from which the method now proposed is free; and the new plan may therefore lead to the introduction of improvements in other branches of manufacture requiring the use of similar materials. Its particular advantages it may be proper to explain.

First, By this new method of moulding muffles, coarser and cheaper materials may be used than can be employed in the common mode; and which also gives them the valuable property of resisting a greater degree of heat.

Secondly, That much time will be saved by this improved method of manufacturing them, will be allowed, when the two modes are compared.

Thirdly, The certainty of making them without cracks or flaws, and with coarser materials, will appear obvious, when it is considered, that by this improved method, they are *internally* moulded instead of *externally*; by which means the strength of the operator may have its full effect, in firmly compressing the composition of the mould.

Whereas, in the old mode, the workman, after having spread the composition upon a cloth, guessing at its thickness, bends it over the block in the best way he can, and by thus disturbing the composition, he must needs make many cracks and flaws, which can be but imperfectly closed in smoothing the surface of the muffle, whilst upon the block; the evil consequence attending which is, its being subject to fly or crack when exposed to a great heat; and it will also be plainly seen, that in the old mode, a great disadvantage is felt by the sides of the muffle, whilst in its wet state, hanging from its centre, and which also tends to crack it, as there can be nothing applied to assist it in this case, but by employing a greater proportion of cohesive clay in the composition, which, however, produces little if any advantage; whereas in the mode adopted by the Inventor of the new process, this fault is entirely obviated, and the composition, by its contraction in drying, assists the extrication of the muffle from the mould.

Fourthly, With respect to simplicity, this new mode will be found to possess a very great advantage, for a boy of twelve years of age may be taught to make them in a very short time.

The fifth advantage in this improvement, and of equal consideration, is the cheapness of the article; the price of which has been reduced nearly one-third to the consumer; and when the superior quality of them is taken into consideration, it may fairly be said to be full one-half. These muffles may be used over again when broken and ground, with a much less proportion of cohesive clay than the common sort; a circumstance which will prove no inconsiderable advantage; for it is well known, that when the old muffles or broken crucibles can be used without much fresh clay, they are far superior to new materials.

Sixthly, The muffles made in the old way are seldom of equal thickness; whereas those made according to the new method will be found to possess that necessary quality in perfection: for, if a hundred are made from the same mould, they will all be of the same thickness.

DESCRIPTION OF THE MOULDS AND IMPLEMEMTS.

The first mould for this purpose is a tin one, fig. 1, plate XII, which may be made from a piece of tin the size of the arch, being bent so as to form such a concavity as may best suit the purpose to which it is to be applied; this being done, two square pieces of tin, *a a*, must have an arch cut out of them, of such a size that the diameter thereof may be about three-fourths of an inch less than the diameter of the concave piece before stated; these being soldered to each end of the first-mentioned piece, will form a stand for the hollow part of the mould, and the thickness of the muffle moulded in this will be exactly determined by the edge at each end. A piece of hollow tin, *b b*, may be soldered along the top edge of the mould, to form a better resistance to the great pressure within. The next part of this mould is a flat piece of tin, fig. 2, cut exactly to fit the inside of the mould, the use of which is, to form a solid back to the muffles used for chemical purposes.

The second tool for this purpose is a piece of sheet brass, fig. 3, about six inches long and one broad, which being bent in a semi-circular form, and screwed to a piece of wood extending beyond its breadth about an inch, is used for cutting the small air-holes *c*, fig. 11, in the aforesaid muffles.

The third is the tool or frame, fig. 4, for preventing the contraction of the muffles in drying, which is made of four

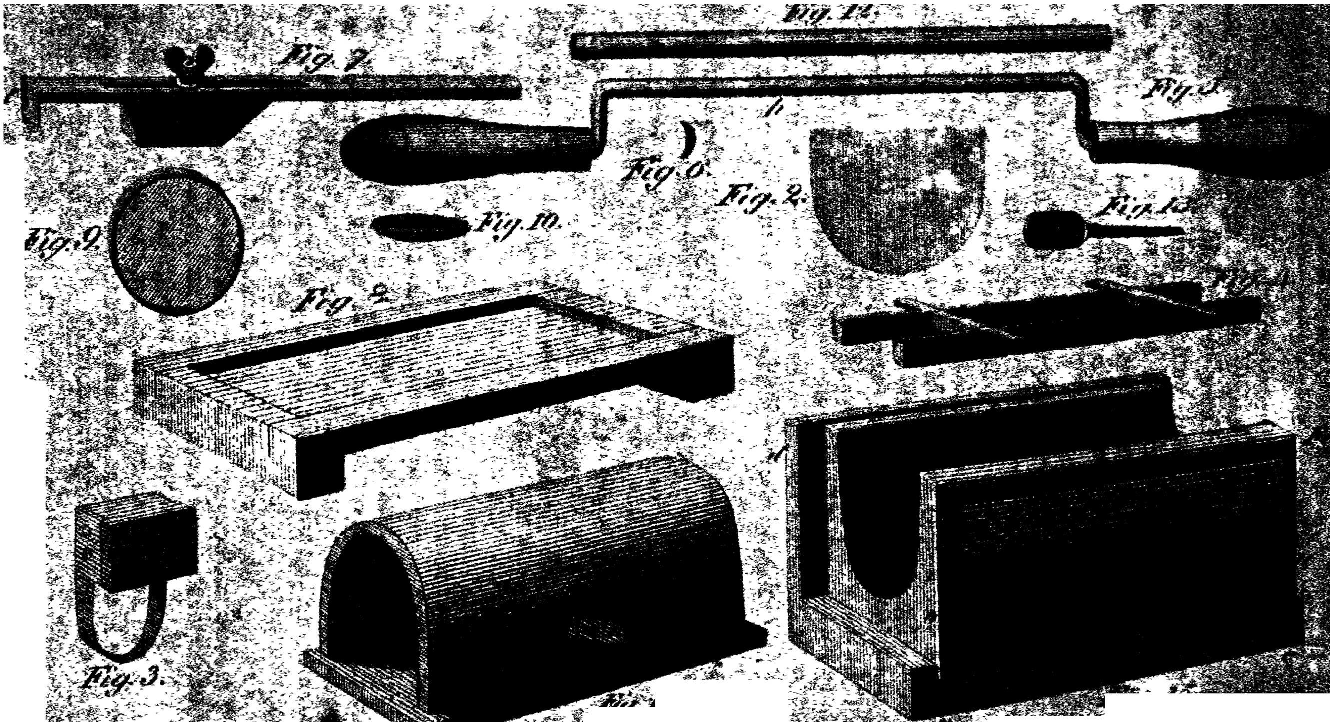
pieces of beech, about three-quarters of an inch broad, and half an inch thick; the length must be adjusted to the mould of the muffle; two of these being laid parallel within the inside of the mould, and being joined across by the other two, the ends of which should extend so far beyond the outer edges of the long pieces, that they may rest upon the edges of the muffle mould, and thereby prevent its falling into the mould.

The fourth is the tool for spreading the composition into the moulds, which is formed of iron or steel, fig. 5, about thirteen inches in length, one inch and a half broad, and about one-eighth thick; its face under *h* being rounded in such a manner that its curve may exactly fit the inner curve of the muffle mould, (fig. 6, is a section of it;) this should likewise have a point or tongue, extending from each end, long enough to be bent in the form of a bricklayer's trowel, and by the wooden handles which must be put on, hanging down, it will be found, that, as it is moved either backwards or forwards, it will always present an edge to smooth the composition, and condense it in the mould.

The fifth is a frame, *d d*, fig. 15, of which the bottom and farthest side only are shown, and in which frame the tin mould, fig. 1, is placed, simply constructed by joining two pieces of wood, the one as broad as the bottom of the muffle mould, and having two narrow grooves, *e e*, cut in it, so that the edges of the tin mould may be confined therein; the other board being joined to this, at its edge, should come up so high as just to be under the edge of the mould.

The sixth is the tool for cutting the muffles of different lengths, fig. 7, and is made of a piece of wood, to the end of which is fixed a thin piece of brass, *f*, which extending about one inch and one-fourth beyond the top of the wood, is bent at right angles, and made thinner at the end, that it may the more conveniently cut the muffle; under this piece of wood is used another straight piece *g*, with two steady pins, which being shifted at the will of the workman, will cut them of any length.

The seventh (see fig. 8) is the mould for forming the bottom of the close muffle, and is made of a mahogany or oaken plank, about sixteen inches long, ten wide, and about three-eighths of an inch thick; upon this is fixed a ledge on each side, one inch broad, and nearly half an inch thick, and at each end a ledge of the same kind is placed, at such a distance as is best suited to the length of the bottom required.


Fig. 12.
Fig. 7
Fig. 5.
Fig. 6.
Fig. 2.
Fig. 9.
Fig. 10.
Fig. 13.
Fig. 8
Fig. 3.

Figs. 9 and 10, are circular moulds for muffle bottoms of dial-plates.

Fig. 11, a complete muffle standing on its bottom.

Fig. 12, a roller for rolling the composition in the first mould.

Fig. 13, a tool for making small holes in the muffle.

The usual composition for making muffles is as follows: viz. two parts pipe clay and one part sand, such as is used by the bricklayers, sifted, and mixed together to a proper consistence; this is very expensive, on account of the high price of pipe clay, which is about ten shillings the hundred weight, whereas in the improved mode of making muffles may be used the coarser kind of Stourbridge clay, which can be had at the glass-houses, in the ground state, for six shillings the hundred weight. This should be sifted, to separate the finer part, which may be employed for making the smaller articles necessary in the business; using only the grosser or coarser part for muffles, with one-eighth part only of pipe clay, mixing the composition well together with water, so as to form a mass of a pretty thick consistence. The tin mould being first greased, place it in the frame, fig. 15, shown under fig. 1, and having spread the composition in the mould, and smoothed it with the spreader, fig. 5, till the mould is quite full, the flat piece of tin is then to be well greased, and thrust in at one end of the mould, and the back of the muffle is then formed by spreading the composition, and firmly pressing it against the part already formed. The next thing to be done is to cut the holes in the sides of the muffle, which is done by pressing the semi-circular cutter, fig. 3, into the sides thereof, while it is yet wet, and bringing the piece out entire: the tin mould must now have the frame, fig. 4, put in, to keep the sides of the muffle from contracting, and being set up endways, and a little inclined, it must be dried in the sun, until it has shrunk sufficiently to leave the mould, after which it must be completely dried and burned in the usual manner.

The composition of the smaller implements, or muffle bottoms for dial plates, for the mould, figs. 9 and 10, is made of the finer part of the Stourbridge clay, with a small proportion of pipe clay.

The rings are made from two parts of Dutch black-lead pots, powdered, and one part of pipe clay. After repeated trials of English black-lead, in various states, as a substitute for the Dutch black-lead pots, the Inventor of these processes did not find it to answer properly.

Machine for Cutting and Crooking the Wires for Cards.

The machine itself is double, having parts to make two complete card wires at once; it receives two wires at once from two reels, on each of which a coil of wire is placed, the wires pass between a pair of rollers, by which they are drawn into the machine, which cuts off a proper length from the ends, and bends the pieces into their proper form, then drops them into a drawer beneath, and proceeds with two others in constant succession; it has been found necessary, for simplicity, to exhibit only one half of the machine, which is, however, by itself a complete machine; and in this division some alterations were necessarily made in the form of some few of the parts, which were common to both halves. The plate is not therefore to be considered as an exact representation of the machine as the Inventor intended it to be used, though it contains all the essential parts and movements.

AA, fig. 2, plate XIII, is the main axis, which puts all the parts in motion; it has a fly-wheel C, fixed on the end of it, and is turned round by a handle B; or it might receive its motion from any machinery, by an endless band or strap and pulley, as it does not require any attendance.

The wire *a a* is conducted from the reel before-mentioned, to the machine, and first passes over a rest or frame *b*, which has a notch in each of its sides, to receive the wires and to keep it down in these notches; it is also passed through a wire eye or ring *c*, to which a sufficient weight is appended to cause such a friction as will keep the wire steady.

The wire next passes through a guide formed by a hole in a piece of iron *d*, fixed by screws to a vertical standard G, rising from the iron frame FF, on which the whole mechanism is erected; by the guide *d*, it is presented to a pair of rollers or wheels D, by which it is drawn forwards; these wheels are exactly of the same size, and being beneath each other, only one can be seen in the figure; the lower roller, which is hidden, is fixed upon an axis which extends across the frame, its ends being supported by the joints of the centre-screws 20 20; the axis is turned round by means of a toothed wheel 7 upon the main axis, acting in another exactly similar to it, fixed immediately beneath upon the axis of the lower roller, which is perpendicular to the main axis; but the teeth of

the wheels being both inclined at an angle of 45 degrees to their respective axes, become parallel at the points of contact, and the wheels turn each other round by a similar action to the endless screw; from which however, this mode of communication differs most materially, in the circumstances of the two wheels or screws, (for they partake the nature of both,) being of equal dimensions and similar forms. This communication causes the lower roller to make a revolution for every one of the main axis. At the opposite end of the axis of the lower roller a cog-wheel is fixed, and operates upon another, E, of exactly similar dimensions, and placed over it so as to conceal the former; this wheel is fixed upon the axis, (shown by dotted lines,) of the upper roller D, which is mounted upon the points of centre-screws held in a frame marked H; this frame is attached to a standard G, of the frame FF, by two centre-screws, so that it will rise on the points of these as on an axis, and thus permit the upper roller to rise and fall to accommodate itself to the wire, and press it so fast upon the lower roller as to draw it forwards; the pressure is occasioned by a strong spring K fixed on the frame I, and its end hooked beneath a projecting part (not shown) of the standard G.

The rollers D, deliver the wire into a steel tube *e f*, (see also fig. 3, where it is shown separately,) the hole through which being but just large enough to admit the wire, straightens it in the manner of dies, and together with the rollers completely takes out any crooks in the wire; the tube *e f* is made in two halves, which are held together by the same clamp screw which fastens them into the bracket L supporting them. The end *f* of the steel dies, which is enlarged, as shown in fig. 3, and has a smooth flat face, is the point where the wire is cut off by means of a small knife *g*, fixed into an axis M, on which is a lever, 5, actuated at the proper interval by the lever or claw 4, on the main axis A, into which it is screwed, and can therefore be readily adjusted in length, to operate more or less upon the lever 5, by which it cuts off the wire at the point where it emerges from the end *f* of the dies *e f*.

The length of wire which is advanced through the dies before it is cut off, is measured by the end of the wire coming up to the flat head of a screw 10, supported by a bracket L; but the instant the wire reaches this, the upper roller D is lifted up so as to relieve the pressure upon the wire; this is done by a cam 1, which has a part of the frame I projecting

over it, and at the end of it is a tooth or knob fastened by the square nut; this tooth is lifted up by the cam, which is a circle having a deep notch cut in it, and thus relieves the wire when the circular part of the cam comes beneath it, and though the motion of the roller continues, the wire remains stationary; the notch presents itself beneath the tooth of I; the spring K now presses the upper roller upon the wire, which is then pushed forward until the proper measure is advanced, when the upper roller will be again lifted up by the cam as before-mentioned; this movement is therefore devoted to measuring the wire, the roller and dies *e f* to straightening it, and the shears or cutter *g*, to cutting it off into the lengths measured by the screw 10.

We have now to explain the mechanism for doubling and bending; these parts are in the plate shown of their real size to render them distinct, though all the other parts are only half the full size. The wire, when advanced by the rollers, is introduced between two pieces of metal *q* and *t r s*, these are shown in all the figures; in figs. 2 and 3 they are only represented by small squares, but figs. 4 and 5 show them to be the ends of levers *q* and *r*, moveable on one common axis, but independently of each other; they are called the back and front blades of the plyers, their axis of motion is parallel to the main axis A, and is suspended between the points of centre-screws supported by the standards GG; this forms the axis of the lever *r*, as shown in fig. 4, which only represents the moving parts; the axis of the lever *q*, marked 15 15, swings between the points of centre-screws attached to a part of the lever *r*, but exactly in a line with the two fixed centre-screws on which *r r* itself moves; thus both blades of the plyers move in the same central line, but independently; they have therefore a motion directly to and from the main axis, but no other. The two levers *q* and *r* have a small spring 19, figs. 4 and 5, between them, which always tends to separate them and open the plyers. The axis 15 of *q* has a short tail or lever 18, rising from it, which stops against an adjusting screw 16, fig. 5, and determines the quantity of approach the end of the blade *q*, (figs. 2, 3, and 5,) shall make towards the main axis; 17 is a spring of a semi-circular form, always drawing the tail 18, towards the screw 16, and consequently urging the blade *q* towards the main axis; the spring 19, also urges the front blade *t r s*, (figs. 2, 3, and 5,) towards the axis, till the arm 11, (screwed to it,) rests upon the outside of the axis; a cam, 9, is fixed on the axis at this part, and

when it comes round acts upon 11, and by it forces the blade *t r s* away from the main axis till it comes in contact with the wire *a a*, (figs. 2 and 4, and shown in fig. 5 by a small black dot surrounded by a white circle,) and presses it against the blade *q*, then holding it in the manner of a pair of plyers, or a finger and thumb, whilst the shears cut it off; all this time the blade *q* may be considered as stationary, the spring 17, fig. 5, which opposes its retreat from the main axis, being so much stronger than 19, which opens the plyers; but as the cam 9 turns farther round, it continues to press the arm 11, and the front blade with it, against the wire, and by this against the other blade *q*, so as to force the plyers back all together on their common axis of motion into the position fig. 3. Now the two ends of the wire being supported by the ends of two levers *h* and *k*, whilst the middle of it is thrust back by the plyers, it is doubled, or has given to it the form of a staple. The action of the levers *h* and *k*, which are called the side-benders, must be explained before this can be clearly comprehended; they have each a motion on their respective centre pins or axes, 21 22, fixed in a plate screwed upon the framing F; these two levers have arms approaching each other in a direct line from one centre to the other, and where they meet have a tooth *i* on the lever *k* entering a notch in *h*, and operating in the manner of a cog, to cause any angular motion which is given to one lever to be communicated equally to the other; this causes the ends of *h* and *k*, where they operate upon the wire, to mutually advance and recede from each other by equal quantities, the motion is given to the benders by a lever *k* 1, which is part of *k*, but has no connexion with *h*, though it passes over it; to the end of *k* 1, a rod *l* is jointed, which passes over the main axis, and has a stud or tooth fastened by the square nut, which is operated upon by a cam on the main axis, and at the proper interval draws *l* and *k* 1, and thus opens the benders *k* and *h* in the manner shown in fig. 2, when this cam passes by the benders shut, or approach each other by the force of a spring *p*, this operates on a lever *n*, which has a pin O rising from it, and pressing back the tooth of the lever *h*, gives them a tendency to shut; this they do the instant the cam has relieved the lever *k* 1, which retires till it rests against a screw *m*, determining the nearest distance they approach to each other, as in fig. 3, and the regulation of the cam on the tooth of the rod *l* which it acts upon, (by means of its square nut,) determines the greatest openings they can have, as in figs. 2 and 4; the ends of the levers *k* and *h*,

where they act upon the wire, have notches in them, through which the wire passes in the first instance before doubling; this is shown in figs. 2, 4, and 5: *t* and *s* are small plates of steel screwed at the two sides of the front blade *r*, of the plyers forming its faces; over these the wire is doubled, by being thrust in between the side-benders, which then close together, as shown in fig. 3 and also in fig. 6; in this state the two legs of the wire, being doubled in the form of &, fig. 1, pass just beneath two shoulders formed upon the steel blade *s*, fig. 4, in the manner explained in fig. 6; these shoulders will of course prevent the legs of the wire staple from rising, and they are bent into the shape of Y, fig. 1, by a lever 8, fixed in the main axis, which passes by at the proper time, and raises the points *a a*, figs 3 and 6, so high, as to give them the proper quantity of knee-bend; this forms the card wire, and when the cams pass by, the plyers and side-benders open into the position of fig. 2, and the card wire drops into a box beneath the machine. Considering the position of fig. 3 as the point of commencement, we will recapitulate the movements of this ingenious machine to render its operation distinct, and show the periods of the different parts of the process. On turning the main axis in such a direction that the handle B. fig. 2, descends, the cams act in the following succession :—

1st, The notch of the cam 1, suffers the roller D to press upon the wire, and thus holds it fast between the upper and lower rollers, which as they turn round,—

2ndly, Advance the end of the wire *a a*, through the dies *e f*, before the notches in the ends of the side-benders *h* and *k*, and between the plyers *q*, and *t r s*, until the end of it reaches the screw 10; at this instant,—

3rdly, The cam lifts up the upper roller D, and the friction on the sides of the frame *e*, prevents its further advance; this is the state in which figs. 2, 4, and 5, represent the machines.

4thly, The cam 9 presses on the arm 11, and forces the blade *r* of the plyers back till the side *t* meets the wire, and removing it backward holds it fast against the front of the blade *q*, and pinches the wire tight between the two jaws of the plyers, whilst,—

5thly, The cam 4 depresses the lever 5, and by the cutter *g* cuts off the wire instantly, leaving it held by its middle between the plyers.

6thly, The cam 9 continuing its motion, drives back both parts of the plyers together and the wire with them; its ends being supported by the ends of the side-benders, it assumes

the bend of the dotted lines in fig. 2. (though the plyers are not there represented as thrown back).

7thly, A notch in the cam of the main axis under the rod *l*, now presents itself, and suffers the spring *p*, to close the side-benders *h* and *k* together, as shown in figs. 3 and 6, which completes the doubling of the wire into the form of &, fig. 1.

8thly, The lever 8, rising, lifts the ends of the wire, and the legs being kept down by the shoulders of *s*, gives them the knee-bend; the manner of this is shown by the dotted lines in fig. 5, though neither the plyers or lever 8 are there in the proper situation to effect this part of the process.

9thly, All the cams, except 1, cease their respective actions at once, and the finished wire drops out of the plyers; thus the cam 4 has, in the interim of the other operation, passed by, and suffered the blade *q*, of the plyers, to return by the action of its spiral spring 6; the cam of the rod *l*, and lever *k* 1, opens the side-benders, the cam 9, passes by, and permits the return of the plyers by the spring 17, fig. 5; but when the tail 18, of the blade *q*, meets its stop screw 16, *q* returns no farther; but the front blade *r*, continues to advance towards the axis, by its spring 19, as fast as the cam 9 suffers it; this opens the plyers, and the wire falls out. The notch of the cam 1, now comes round, and suffers the roller D to descend on the wire, and advance another portion, which is treated in the same manner as the first.

These operations succeed each other with such rapidity, when the machine is in action, that the handle may be turned at the rate of 150 turns per minute, without in the least injuring its operation; and the power required to turn it is so small, that one person might turn a dozen; or, if they were turned by a mill, he could attend a greater number, as they very seldom act wrong, or make a false wire.

The machine is capable of making wires of any size, by means of the following adjustments:

1st. The length of the notch in the cam 1, regulates the length of the wire which shall be cut off, because it is only as long as this notch is presented to the lifting tooth of the frame I, that the rollers act upon the wire: the screw 10 is adjusted to stop the wire when sufficiently advanced; but this is only a precaution to prevent any accidental protrusion after the cam 1 has lifted the roller. The cam 1, as before stated, is a circle; and, to have the means of adjusting the length of the notch in it, the cam is made of two equal circles, or wheels, fitted on the main axis, and applied to each other side by side,

Beard's machine for cutting and crooking the wires for cards.

so as to make one; the beak of the frame I, which rests upon their circumference, is as broad as both circles together; each has a notch cut in it, much wider than the notch in the cam is ever intended to be.

Now, if these circles were twisted round on the axis, so as the notch in one circle was applied opposite to the complete part of the other, the cam would act as a complete circle, and the tooth of I would never drop in the notch of either, because the circumference of the other circle would hold it up at the time; on the other hand, by placing the two notches opposite to each other, the rollers would be suffered to act upon the wire longer than is ever intended; therefore, between these two extremes, the limits of the notch may always be determined by trial, that the proper length of wire shall be protruded; one circle making the beginning, and the other the end of the notch in the cam; both are fastened on the axis by clamp screws.

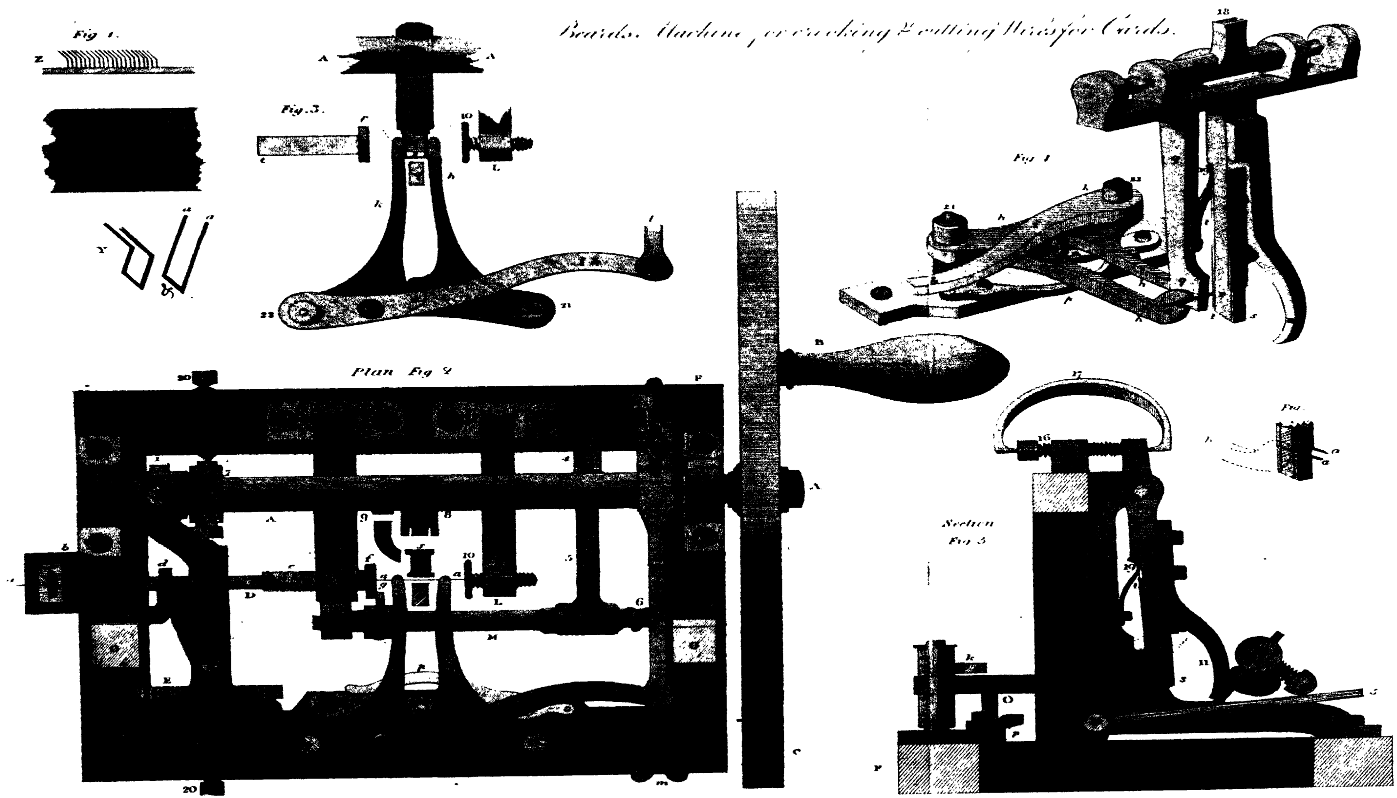
2nd. The centre-screws, on which the whole of the plyers *r r*, fig. 4, are suspended, admit of adjusting them, that their blades shall seize the wire by the middle, and make the ends of the staple equal when doubled.

3rd. The steel faces *t* and *s*, of the blade *r*, of the plyers can be removed, and any other substituted, this regulates th distances between the legs and parts of the card wire, or the length of its shank.

4thly. The screw *m* determines the degree of closure the side-benders shall have, and the square nut on the rod *l*, (which attaches to it the piece on which the cam operates,) determines the distance to which they will open; this is of consequence, for the wire, if bent too suddenly at once, into the dotted position, fig. 3, might be cut or broken, instead of being bent fairly.

5th. The screw which fixes the lever 8 into the main axis, admits the lever to be set further out, and then it will give a greater degree of knee-bend; or, if nearer to the axis, will bend less; this is also influenced by the quantity of motion the cam *g* gives to the plyers, which can be adjusted, by sliding the curved arm 11, up or down the lever *r*, for which purpose, its screws are fitted in grooves; this causes a more or less protuberant part of the curve 11, to meet the cam 9; the screw 16, as before stated, adjusts the blade *g* of the plyers.

Beard's Machine, for cracking & cutting Wires for Cards.



New Methods of producing straight, smooth, and parallel, or globular Surfaces, by Machinery.

For the inventions, which form the subject of this article, a patent was taken out, the specification of which is dated October 30, 1802. The specification is much involved in the obscurity of general terms, and the technical phraseology of legal instruments; perhaps the nature of the invention required such a style of expression, for the patentee's security: however this may be, we shall endeavour to give the main hints in plain English. Some of the plans proposed will doubtless be highly valued by practical men, and will probably become, when generally known, the standard methods of working. This remark has particular reference to the contrivance of supporting a revolving vertical shaft on a fluid body, and to that by which the great difficulty of turning perfect spheres is overcome.

The merits of these inventions do not so much rest on any novelty in the general principle of the machinery employed, as on the new application of principles already known, and machinery already in use for other purposes, in various branches of British manufacture. This machinery, and the new manner of using it, with some improvements in the construction, together with various tools and appendages never in use before, may be described as follows:

The patentee uses, to accomplish his objects, every kind of edge-tool or cutter already known, either in their usual shape, or with such variations as the occasion calls for; but such tools, instead of being applied by hand, as judgment may direct, are fixed in frames of different kinds, in connexion with machinery.

With regard to the principles of the invention, first, the materials intended to be wrought true and perfect, are caused to slide in contact with the tool, instead of the tool being carried by the hand over the work, in the usual way.

Secondly, the tool is made to traverse the work in a square or oblique direction; except in some cases, where it may be necessary to fix the tool or cutter in an immoveable station, and cause the work to fall in contact with it, as in the operations performed on a drawing-bench.

Thirdly, for common saws, axes, chisels, or other instruments usually applied by hand, are substituted cutters, knives, shaves, planes, and the like, in the form of bent knives, spoke-shaves, or deep-cutting gouges, similar to those used by turners for cutting off the roughest part. These are followed by tools called finishing tools.

Fourthly, these cutters, knives, &c. are fixed in frames, called cutter-frames, in such a manner that they may be easily detached for the purposes of being changed or sharpened. The Patentee sometimes fixes the cutter-frames so as to reciprocate in their motion vertically, like the saws in a sawing-mill, and sometimes to reciprocate horizontally, they being all the time confined in grooves, or some equivalent contrivance. In other instances, which he apprehends will in general have the preference, he fixes the cutter-frame on a rotary upright shaft, turning on a step, and carrying the frame round in a direction similar to an upper mill-stone; and sometimes he causes the frames to turn with a horizontal shaft, just resembling the mandrel of a common turning lathe, or those machines used for cutting logwood, for the dyers' use. When these frames are mounted in any of the foregoing methods, the materials to be wrought, are reduced gradually to the line intended for the surface; the cutter-frames being regulated by a screw, &c. so that they may be made to advance or recede, at pleasure, in order to take a deeper or shallower cut, or that the machine may repeat its action, without raising or depressing the materials on which the cutters act. The magnitude of the cutter-frames must of course be regulated by the work, only observing, that the diameter of those on the rotary plan, must exceed twice the width of the material to be cut; because the material must slide so as to pass the shaft on which the cutter-frame revolves.

Fifthly, when upright shafts are mentioned, for the purpose of carrying cutter-frames, it is not meant, that the lower end or point of such shafts shall come in contact with, or rest on the bottom of the step or box in which they stand, nor that such shafts shall rest, or turn on any point unalterably fixed, but the pivot or lower point of the shaft shall actually rest and turn on a fluid body, such as oil, or any other fluid which may be found proper for the purpose, a considerable portion of which should always be kept between the lower point of the shaft and the bottom of the step in which it works. The said shafts may be raised or depressed at pleasure, by means

of a greater or less quantity of the said fluid being confined between the end of the shaft and the bottom of the step. This device* the Patentee considers of great consequence in all kinds of machinery, where massy and heavy-loaded upright shafts are used ; and he performs it in the following manner :— The lower part of the shaft must be turned perfectly smooth and cylindrical, to a height something above the greatest distance or length the shaft will ever be required to be raised or depressed when in use. To this part of the shaft is adapted a hollow cylinder, which fits its circumference so as to allow freedom of motion, but to prevent shaking. This hollow cylinder he calls the step-cylinder; its length must be nearly equal to that of the cylindrical part of the shaft above-mentioned, so that when the point of the shaft rests on the bottom of the step-cylinder, the finished cylindrical part of the shaft may be something above the top or upper end of the step-cylinder. In the upper end of this step-cylinder, he makes a stuffing-box, by means of a double cupped leather, or other materials surrounding the cylindrical part of the shaft, in such a way as will cause the junction, when the shaft is passed through it, to remain water-tight, under any pressure that may be felt from the efforts of the fluid retained underneath it, to make its escape upwards through this part, or stuffing-box, when the shaft, with all its load, is passed through it, and immersed in the step-cylinder. When this is done, the injecting-pipe of a small forcing-pump, similar to those used in his patent-press, (described in a subsequent article,) must form a junction with the step-cylinder in some part below the stuffing-box ; then the pump being worked, the oil or other fluid injected by it, will, by pressing in all directions, cause the shaft to be raised from its rest, on the bottom of the cylinder, and to slide up through the stuffing-box, like the piston of the patent-press just alluded to ; and by this means, the shaft, with all its incumbrance, may be raised to any given point that will not throw the stuffing-box out of the step-cylinder, while it will be left resting on the fluid under it, whatever the quantity or thickness of such fluid may be, between its point and the bottom of the step-cylinder. By this means, the shaft, although, with its accompaniments, it may in weight amount to hundreds or thousands of tons, can be easily raised or

* Count de Thiville was the author of a similar invention. See Repertory of Arts, vol. 14. 1st series.

depressed, by the alternate injection or discharge of the fluid used, exactly as the same operation is performed in the patent-press; and when it is at work, all friction will be avoided, except that of the stuffing-box, which will be comparatively trifling, to what would result from the resting of such a shaft on the bottom of the step in the usual way. Thus will be gained a very important advantage, and there cannot be a doubt, that if the stuffing-box be made perfectly fluid-tight, a shaft thus buoyed up, would continue in good order for years.

Sixthly, the material to be wrought must be firmly fixed on a platform or frame, made to slide with perfect truth, either on wheels, or in grooves, &c. similar to those frames in a saw-mill, on which the timber is carried to the saws. These frames must be moved in a steady progressive manner, as the cutter-frame turns round, either by the same power which moves the latter, or otherwise, as may be found in practice to answer best. This motion must be under the power of a regulator; so that the motion of the sliding frame may be properly adjusted, according to the nature of the work. The motion of the cutter-frames must also be under the control of a regulator; so that the velocity of the tool, in passing over the work, may be made quicker or slower, as such work may respectively require, for the purpose of causing the cutter to act to the best advantage.

Seventhly, the Patentee often regulates the motions of his apparatus, by means of a new invention, which he calls a universal regulator of velocity, and which is composed as follows:—He takes any number of cog-wheels, of different diameters, with teeth that will exactly fit each other through the whole; for example, suppose ten wheels, the smallest of which shall not exceed one inch in diameter, and the largest ten inches in diameter, and all the rest to mount, by regular gradations in their diameters, from one to ten. These ten wheels are immoveably fixed on an axis, perfectly true, so as to form a cone of wheels. Then take ten other wheels, exactly the same in all respects as the former, and fit them on another axis, also perfectly true; but these latter wheels must not be fixed on their axis, like the former; but must be all left loose, so as to turn upon the said axis. A contrivance is adopted for locking these loose wheels; for example, by a pin, so that any single wheel may, at discretion, be locked or set fast. The two axes are placed parallel to each other, with the wheels which form the two cones, as above described, in reverse position, so that the large wheel at the end of one series may lock its teeth into the smallest wheel of the other, and *vice*

versâ. Then suppose the axis on which the wheels are permanently fixed to be turned about, all the wheels on the other axis will be carried round with an equal velocity with the former, but their axis will not move. Then lock the largest wheel on the loose axis, and by turning about the other axis as before, it must make ten revolutions, while the opposite performs but one: then by unlocking the largest wheel and locking the smallest one at the contrary end of the cone, and turning as before, the fastened axis will turn the opposite ten times, while itself only revolves once. Thus the axes or shafts of these cones, or conical combinations of wheels, may turn each other reciprocally as one to ten, and as ten to one, which collectively produces a change in velocity under a uniform action of the first mover, as ten to a hundred; for when the small wheel on the loose axis is locked, and the fast one makes ten revolutions, the former will make a hundred: By adding to the number and size of these cones of wheels, any variations required in velocity or power will be obtained; and a regulator, thus constructed, will in general be much more convenient, than if only one wheel were placed at a time upon each axis, and changed for others when any alteration of power or velocity were required.

Eighthly, when spherical surfaces are to be produced, perfectly true and equidistant from their centres in all directions, he fixes a tool adapted to the material, upon a cutter-frame, fastened to the rest of any common lathe, so as to present its point exactly to a line drawn through the centre of the mandrel of the lathe horizontally; and the said frame on which the cutter is fixed, must admit of being drawn out at pleasure, to any required distance, to accommodate the diameter of the sphere intended to be produced. The cutter-frame must likewise be made to turn upon a centre, or pin, very firmly fixed on the rest above-mentioned, so that the cutter may be turned by its frame round a centre exactly perpendicular to the axis of the lathe-spindle, to the height of which axis the height of the point of the tool must be set. When this is done, and the wood or other material to be wrought, is fixed on the lathe in the usual way, the cutter-frame must be drawn nearer, or farther distant from the centre upon which it turns, to accommodate the diameter, just the same as a common rest. If the material be rough, and require to be reduced to a spherical form by gradations, the workman will see the propriety of taking hold but lightly at first. By this simple apparatus, the difficulty of turning perfect spheres is overcome;

as it must be obvious to any mechanic, that while the work is turning in the lathe in a vertical direction, and the tool or cutter is, by the hand or otherwise, turning in a perfectly horizontal direction, round a centre opposite to the actual centre of the sphere, the point of the tool or cutter must of necessity generate or turn a perfect sphere, true in all directions; and by this method, spheres of any practical magnitude may be cut with perfect ease and exactness.

Ninthly, when concave surfaces are to be produced, perfectly true and smooth, the work is fixed on a machine, the same in all respects as a common turning lathe; the tool is then fixed on a centre, exactly in a line, both perpendicular to, and on a level with the exact centre of the shaft or mandrel on which the work revolves; and the point of the tool projects to the required radial distance; so that when the work goes round by the revolution of the lathe, the tool or cutter at the same time revolving round its centre, a spherical concave will be produced by its point.

Tenthly, the Patentee converts solid wood or other materials, into a thin concave shell, similar to a dish, by cutting these forms alternately out of each other, beginning at the smallest, by means of another tool or cutter, likewise moving on a stationed centre, as before, exactly on a level, and perpendicularly true with the centre of the mandrel of the machine on which the work is fixed. The shank or stem is bent to the exact circle the concave is meant to have; it is then fixed on an arm or frame calculated to receive others of different circles; and in fact the same frame may be used which is above described to hold the tool for cutting spherical surfaces, either convex or concave. The tool must be fixed on this frame or arm, at such a radial distance from the centre on which the frame or arm turns, as to form a quadrant with one leg, turning on its centre, and the tool forming the periphery with its cutting point projecting to the line of the deficient leg. Before this tool begins its action, a common rest must be applied close to the face of the work, in order to support the tool when it begins to cut; and on this rest the tool will slide till its point, proceeding under the control of the centre on which its frame is fixed, reaches the horizontal line of the lathe's centre, when the part cut off, or the inner dish, will fall from the stock, which will be left for the operation of another tool, of a larger circle.

New Methods of applying Power to Machinery.

For this invention, a patent was taken out in 1796, and the term is therefore now expired: the specification contains perhaps the first public suggestion for applying to machinery and the arts of common life, powers which were previously confined to the circles of philosophy.

The merits and particular advantages to be derived from this invention principally depend on a new and peculiar method of applying water, or other dense fluids, to operate in various engines and kinds of mechanical apparatus; so as, in some instances, to cause them to act with immense accumulated force; in others, to communicate the motion and powers of one part of a machine to some other part of the same machine; and, in other instances, for the purpose of communicating the motion and force from one machine to another, where their local situations preclude the application of all other known methods of connexion. There is likewise a vast variety of other instances, in which the new application of fluids will be found of great importance and utility, though not here to be enumerated: the figures referred to below, will, however, fully explain the nature of the invention.

Fig. 1, plate XIV, is the section of a machine literally nothing more than two pumps of different dimensions acting on each other, which will be sufficient to elucidate the first and most material part of the invention; namely, that by the application of water, and other dense fluids, various engines and kinds of apparatus may be rendered capable of operating with immense force, for every purpose where accumulated power is necessary.

A, is a cylinder of iron, or other materials, sufficiently strong, and bored perfectly smooth and cylindrical; into this cylinder is fitted the piston B, which must be made perfectly water-tight, by leather or other materials, as used in pump-making. The bottom of the cylinder must also be made sufficiently strong, with the other part of the surface, to be capable of resisting the greatest force required.

In the bottom of the cylinder A, is inserted the end of the tube C, the aperture of which communicates with the inside of the cylinder, under the piston B, where it is shut with the small valve D, like the valves of a common pump.

The other end of the tube C, communicates with the small forcing-pump or injector E, by means of which, water or other

dense fluids can be forced or injected into the cylinder A, under the piston B.

Now, suppose the diameter of the cylinder A to be 12 inches, and the diameter of the piston of the small pump or injector E only one quarter of an inch, the proportion between the two surfaces or ends of the said pistons will be as 1 to 2304; and, supposing the intermediate space between them to be filled with water, or other incompressible fluid, the force of one piston will act on the other, just in the above proportion, namely, as 1 to 2304. Suppose the small piston in the injector to be forced down, when in the act of pumping or injecting water into the cylinder A, with the power of 20 cwt. which could easily be done by the lever H; the piston B would then be moved up with a force equal to 20 cwt. multiplied by 2304. Thus is constructed a hydro-mechanical engine, by which a weight amounting to 2304 tons can be raised by a simple lever, through a certain space, in much less time than could be done by any apparatus constructed on the known principles of mechanics; and it may be proper to observe, that the effect of all other mechanical combinations is counteracted by an accumulated complication of parts, which renders them incapable of being usefully extended beyond a certain degree; but in machines constructed on this principle, every difficulty of this kind is obviated, and their power subject to the interposition of no such restraints. To point out how extensively the force of any machine acting upon this principle may be increased, it will only be necessary to remark, that it may be done either by enlarging the proportion between the diameter of the injector and the cylinder A, or by applying greater power to the lever H.

Figs. 2, represents the section of an engine, by which very wonderful effects may be produced instantaneously, by means of compressed air.

AA is a cylinder, with the piston B fitting air-tight, in the same manner as described in fig. 1.

C is a globular vessel made of copper, iron, or other strong materials, capable of resisting immense force; it is similar to the balls of air-guns.

D is a strong tube of small bore, in which is the stop-cock E. one of the ends of this tube communicates with the cylinder, under the piston B, and the other with the globe C.

Now, suppose the cylinder A to be of the same diameter as that in fig. 1, and the tube D equal to one quarter of an inch in diameter, which is the same as the injector fig. 1; then

suppose that air is injected into the globe C, (by the common method,*) till it presses against the stop-cock E with a force equal to 20 cwt. which can easily be done; the consequence will be, that when the stop-cock E is opened, the piston B will be moved in a cylinder AA with a power or force equal to 2304 tons; and it is obvious, as in the case of fig. 1, that any greater degree of force may be acquired by machines or engines thus constructed.

Fig. 3 is a section, merely to show how the power and motion of one machine may, by means of fluids, be transferred or communicated to another, let their distance and local situation be what they may.

A and B are two small cylinders, smooth and true; in the inside of each of them is a piston made water and air-tight, as those represented in figs. 1 and 2.

CC, is a tube conveyed under ground, or otherwise, from the bottom of one cylinder to the other, to form a communication between them; this tube is filled with water, or other fluid, until it touch the bottom of each piston; then by depressing the piston A, the piston B will be raised, or *vice versâ*. Thus bells may be rung, wheels turned, or any machinery put in motion, by a power at a great distance, with very little loss by friction.

Fig. 4 is a section, showing another instance of communicating the action and force of one machine to another, and how water may be raised out of wells, of any depth, and at any distance from the place where the operating power is applied.

A, is a cylinder, of any required dimensions, in which is the working piston B, as in the foregoing examples; into the

---

* To those who are unacquainted with the mechanism of an air-gun, the "common method" here alluded to, for condensing the air into a hollow metallic globe, may not be understood. It may therefore be observed, that such a globe is furnished with a valve opening *inwards*; over this valve is screwed a tube, open at both ends; to this tube is fitted a solid piston, to which is fixed a rod for working it; at the top of the rod is a handle like that of an augre, for the purpose of using considerable force. When the piston is drawn up, a vacuum is created below it, till it reaches above a small hole in the side of the tube, when the atmospheric air rushes in, and fills the tube; the piston is then pushed down, and when it has passed the hole in the side of the tube, the air has no way of escape but into the globe, the valve in which allows it to enter but not to escape. By continuing the operation, ten or even twenty times the quantity of air which the globe would naturally contain, may be forced into it, because air is a compressible fluid; but as its efforts to expand are always in proportion to the compressing force, its power, when set at liberty from this state of condensation, is prodigious.

bottom of this cylinder is inserted the tube C, which may be of less bore than the cylinder A. This tube is continued, in any required direction, down to the pump-cylinder D, (supposed to be fixed in the deep well EE,) and forms a junction with it above the piston F.

The piston F has a rod G, working through the stuffing-box, as is usual in a common pump.

To the rod G is connected, over a pulley or otherwise, a weight H, sufficient to overbalance the weight of the water with which the tube C is filled, and to raise the piston F when the piston B is lifted. Thus, suppose the piston B to be drawn up by its rod, there will be a vacuum made in the pump cylinder D, below the piston F: this vacuum will be filled with water through the pipe K, which descends into the water of the well; this effect being produced by the pressure of the atmosphere as in ordinary pumps. The return of the piston B, by being pressed downwards in the cylinder A, will make a stroke of the piston in the pump-cylinder D, which may be repeated in the usual way by the motion of the piston B, and the action of the water in the tube C.

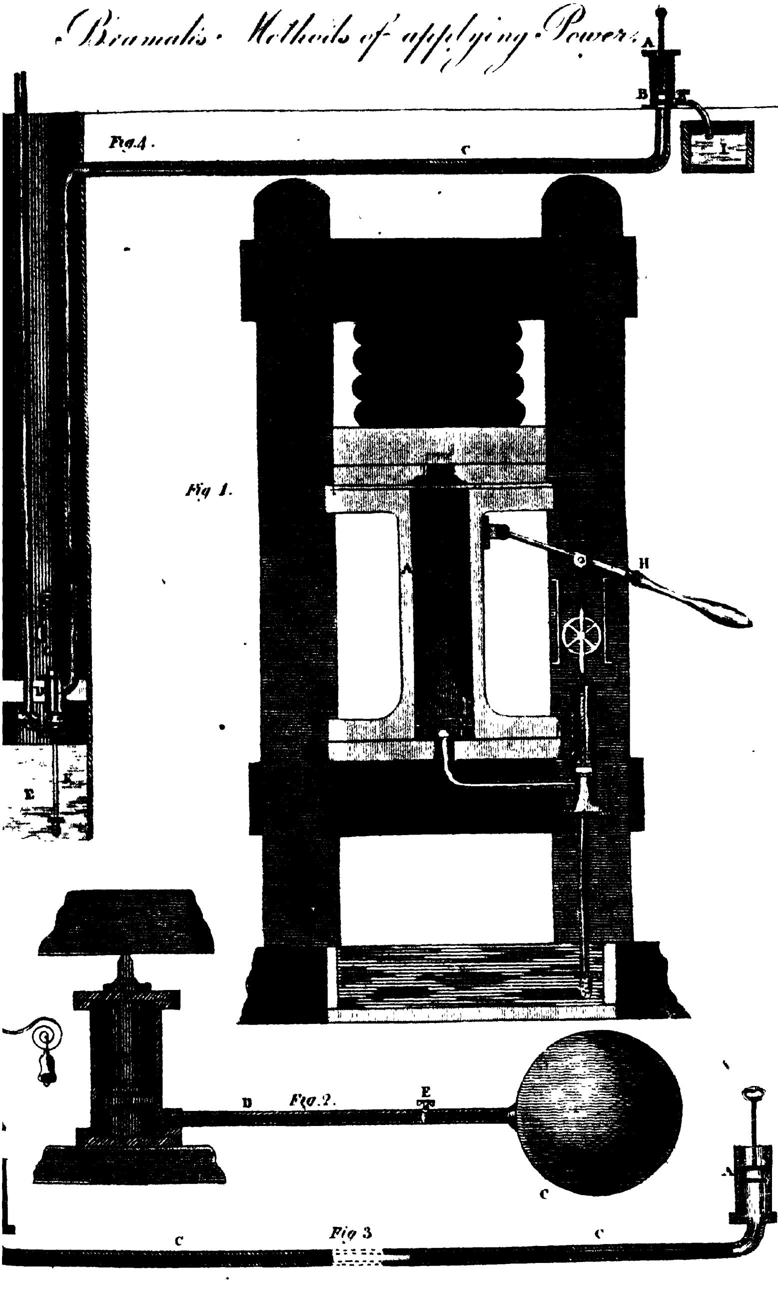
The rod G, of the piston F, and the weight H, are not necessary in wells of such a depth that the atmosphere will overbalance the water in the suction of the pump-cylinder D, and that in the tube C.

The small tube and cock in the tube I, are for the purpose of charging the tube C with water.

Of machines constructed upon the principles above-detailed, the chief advantage lies in their affording the means of exerting an immense power in a small compass, and with less friction than ordinary machines, effecting the same purpose with equal convenience. Hence, although, as in all other cases, where power is gained, time is lost, yet less than usual is lost of that time and power spent in overcoming the imperfections of a complication of parts. The invention deserves particularly to be considered, so far as regards the communication of motion by means of fluids, through a long course, whether in a right line or with one or more turns.

The hydrostatic press, which was first proposed to the public as above detailed, is now admitted to be the most valuable of all machines for applying pressure, and is rapidly superseding the use of the screw. We shall, in the sequel of this work, give an account of the present much improved method of constructing it.

Bramah's Methods of applying Power.



Published by Henry Fisher, Caxton, London 1823

Method of securing Timbers or Girders injured by the Dry-rot or by Time.

The devastations of the dry-rot, in the timbers of houses, are so frequent, that next to the method of entirely preventing them, the easiest and most effectual methods of repairing the mischief, becomes an object of important inquiry. The usual remedy is new timber; but the subsequent details will afford proof that this is not often necessary, while they point out the contrivances to be resorted to, and which those artizans who might be called in when the damage was detected, might be loath to exert themselves in equalling, even if they should have the ingenuity to conclude that repair might supersede renewal.

Fig. 1, plate XV, represents the method employed, at the house of Hennege Legg, esq. at Putney, in Surrey, to support the girders or beams, where their ends or bearings were entirely destroyed. Had not this, or some similar plan been put in execution, new girders must have been inevitably introduced, for reasons hereafter noticed. The bearing is not less than twenty-nine feet; and the roof must have been completely taken off, owing to the gutter-plate being placed across the girders, and the roof a double one.

The ceiling of the drawing-room, which is immediately under the girders, must also have been destroyed. This ceiling is highly ornamented, and supposed to be in value £500, to which sum, if the expense of taking off the roof, &c. is added, it would have cost £800 to have reinstated the work; whereas the iron braces and workmanship only amounted to twenty pounds, for securing the four ends of the girders, the ceiling, and the roof.

Where the ends of girders are decayed by time, or injured by the dry-rot, although the girders are taken out, and new ones put in their place; yet, if the dry-rot is in the walls, the ends of the new timber will be in danger of it again. This was the case at Eltham, in Kent, where, in one house, there were three new girders to one floor in the space of twenty years; but the method now proposed will be found certain in addition to the smallness of its expense, as the timbers are left not subject to the dry-rot, because the end of the girder may be cut off clear from the wall; and if an air-grate

is put on the outside, so as to admit air to the end of the girder, it will remain safe from injury.

A, fig. 1, shows the end of the decayed girder, with the braces applied upon it.

BB, the templets or wall-plates on which the girder rests.

CCCC, one of the iron levers for raising and supporting the girder (there being a similar one on the opposite side.) This lever is moveable on a pin D, which comes through a hole in the lever, distant about two feet from the end of the girder. This pin forms part of a collar E, bedded in the girder. The lever is six feet long, three inches wide, and three-fourths of an inch thick, and extends from the wall-plate along the side of the girder.

The extremity of the lever is moveable on another pin F, projecting through it from an upright iron G, bedded in the side of the girder, and carrying a nut and screw, that act on a cross-plate H, through which the upright iron passes.

At the other end of the lever, next the templet, is an iron collar I bedded in the girder, which collar may be raised or lowered at pleasure, by means of the nut and screw K, forming part of it; and by aid of the cap-plate L, which presses upon the lever, and also clasps it to the girder by its bend at L.

As fig. 1 shows only one side of the girder, and (as before observed) there being also a similar lever on the opposite side of the girder, their separate parts, method of connecting them, and their mode of action, are more fully explained in reference to figs. 2, 3, 4, where the same letters are made use of to point out the several parts.

Fig. 2, E, shows the whole of the collar to be bedded in the side and bottom of the girder, and the pins DD, on which the two levers are moveable.

Fig. 3, the cap-plate H, the two upright irons GG, with their nuts and screws, which act upon the extremities of the two levers by means of their pins FF.

Fig. 4, the collar I, on which that end of the girder next the templet rests, the sides of which collar are bedded in the girder. CC are the claws or bended legs of the two levers which go into the templet. L is the cap-plate; KK are the nuts and screws.

At the house first alluded to, where these levers were applied, the beams of the roof were so decayed, that the roof was in imminent danger, the bearings were entirely rotten, and the beams were sunk three-fourths of an inch, and

pressing against the wall for support: if there had not been a large cornice underneath, supported by brackets, the whole roof must have fallen. To repair the mischief, the first step was to put shores or supports under each end of the two beams, on which the double roof lay, and the four shores were forced at once, for the security of the roof, the work, and men. The iron levers, C, were then prepared, let into the templet, and fixed on each side of the beam, on the pins D, projecting from the collar E, bedded in the beam, about two feet from its end. When the whole apparatus was ready, on screwing the nuts on the upright irons G, at the extremity of the levers, the beam was raised to its proper height with great ease, although it was supposed that there was above two tons weight on each beam, on account of the lead-gutter, and gutter-beam betwixt the double roof, and the rich ornamented ceiling attached to the joists. The ceiling was not injured, except where the iron-collar E was fixed, which was put up from the under side by cutting the ceiling the width of the collar. These beams were so decayed and hollow, that the common method of bolting plank on each side of the beam would not have been safe; and if it could have been executed, as the new planks would have been subject to the dry-rot, the roof would still have been in danger. The beam ends were cut clear from the walls, and the beams left suspended by means of the iron-levers, the feet of which rest on the templets of the walls. An air-grate was made on the outside of the wall, to admit a current of fresh air to the ends of the timbers. The roof is now much safer than when originally made, as the timber is secured from decay; and, owing to the collar E, the bearings are not two feet shorter at each end of the beam.

After the beams were brought to their proper height, and the levers and screws adjusted, screw-bolts were put into the timber, through holes purposely left in the lever, betwixt D and F, and the whole work thus perfectly secured.

At M, the further end of the girder, fig. 1, is shown another method of supporting timber, where the ends are decayed. The particular irons used in this way are shown by fig. 5. N is a collar for the girder; O, an iron frame which rests on the templet; PP, two nuts which raise the collar N. RR show the clawed ends of the two bars of iron, extending under the girder, bedded therein, and screwed to it at their extremities, about five feet distant from the templet.

Fig. 6, is one of the iron bars last mentioned.

S is the claw or lap which projects over the collar N.

T is the place where it is screwed into the girder.

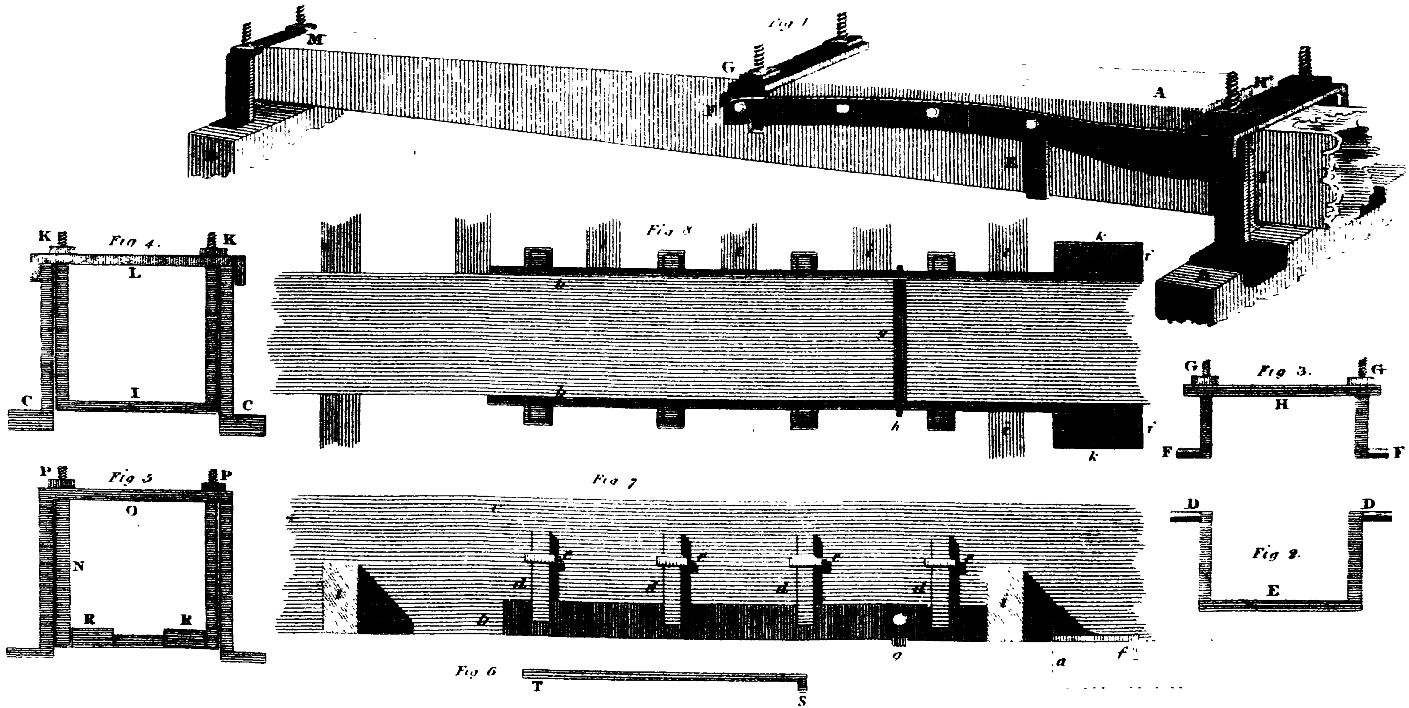
Figs. 7 and 8, explain a third method of securing decayed timbers.

Fig. 7, gives a side view of a decayed girder; *a* represents the templet; *b*, an iron lever, six feet long, with nearly parallel sides, being only cambered one inch; it is three inches wide, and three-quarters of an inch thick; this lever extends along the side of the girder *c*, and is secured firmly to it by the side-irons *d d d d*, which are two inches wide, and full half an inch thick, pointed at the ends. The higher ends of these side-irons are driven into the girder, and the lower points pass through holes in the lever, into the lower part of the girder, and are held close to the girder by staples *e e e e*; the side-iron next the templet may be fixed slanting, in order that it may enter the sounder wood. A claw *f*, which is part of the lever, rests on the wall-plate *a*, and is bedded in it; an iron plate, *g*, lying under the girder and let into it, passes through the lever at *h*, connecting it with a similar lever on the opposite side, and which assists in the same way to support the girder: *i* is a flooring joist, to show how deep the levers are inserted therein.

Fig. 8, shows the under part of the same girder; *b b* are the bottoms of the two levers above-mentioned, fixed to the girder by the side-irons and staples before described; *k k*, the broad feet of the levers, which lie flat upon the wall-plate; *f f*, the two claws projecting from the feet, in order to bed in the wall-plate. *i i i i*, are joists, partly cut through, to admit the iron levers to lie close to the girder; *g*, shows the iron plate or collar on which the girder bears; it is turned up an inch and a half at each end, to keep the levers close to the side of the girder. This collar should be made out of inch-bar iron, with points projecting from it, in the same manner as the collar at DD, fig. 1, to connect it with the levers by passing through holes made in them for that purpose.

To fix the levers, put a shore two feet six inches from the wall, under the girder, to support it; then cut off the decayed end, and take out the templet, or part of the wall-plate, if decayed; and put in a stone templet for the irons to rest upon, with mortises in the stone to admit the claws of the lever: then fit the collar underneath the girder, two feet from the wall, to answer the holes in the lever; make an incision in the joints three-fourths of an inch wide, and three inches deep, to admit the levers; fix the levers on each side with the collar, so as to force up the levers together;

[illegible] Method of supporting decayed Timbers



I Smith Liverpool

then with slight shores, force up the ends of both levers together, and fix the side-irons firm. The girder will thus become perfectly safe.

The templet or wall-plates, on which the levers rest, should be made of Portland or some other good stone, three feet long, nine inches wide, and five inches deep, with incisions or mortises made therein for the claws of the levers.

Machine for keeping an Account of the Number of Draughts from a Mine.

The inventor of this machine had been applied to, by gentlemen engaged in coal-mines, to furnish them with a contrivance, which would infallibly tell the number of boxes of coals drawn out of a pit in the course of a week, or any given time. Perhaps in no branch of business, is it of more importance than in mining, for a proprietor to have an unerring check upon the negligence of some, and the artfulness of others. How far this machine, which is very simple, and not necessarily expensive, has accomplished the object intended, will be indicated by the following view of its properties.

1. It is of no consequence whether the pit be ten, twenty, forty, or more yards deep. The machine will, notwithstanding this difference, only point out one box at once; and supposing the pit to be several hundred yards deep, the principle will remain the same, and it could easily be adapted to the occasion.

2. It is likewise of no consequence, whether the coals be drawn up by a hand-windlass, or any machine turned by horses or other powers.

3. No account need be kept for a whole week, or any given time; as the machine can be calculated for any quantity of coals whatever, that can be drawn up in a given time. Only allowance must be made for the number of persons that go down and up in the same way.

It is to be observed, that the rope must be so long, that when fastened at its middle to the windlass, each end of it will reach to the bottom of the pit.

Antis's machine for keeping an account of the draughts from a mine.

The roller A, fig. 1, plate XVI, with the endless screw, represents the gudgeon of a hand-windlass. As no great stress is laid upon this screw, it may, in order to save labour, be made of brass, and driven or otherwise fastened upon any gudgeon. The windlass may be taken at one yard in circumference; and, from the number of teeth in the first wheel B. forty revolutions of the windlass are required before the wheel B, upon which the brass catch C is fixed, turns once round. The pit, therefore, may be only ten yards, or from seventy to seventy-five yards deep, yet it will make no difference. All that is required to regulate the machine to the depth of the pit is easily arranged:—If the pit be little more or less than ten yards, the first wheel must be so placed in the endless screw, that the brass catch C may be, at the beginning, but just escaped from a tooth of the second wheel D. It will then only want five or six revolutions of the windlass backwards, before the said catch is ready to operate again. But supposing the pit to be seventy yards deep, in this case, the catch C must be placed so as to be nearly ready to act. By turning backwards, the wheel may very nearly make two revolutions; and as it can be still turned as far the other way, the catch will only act once, provided the said wheel does not quite make two revolutions. The index will at once show how many times fifty boxes, and how many above or below that number, have been drawn up; not one of them can escape: allowance, as before observed, being made for the number of persons who go up and down the same way; and besides this, as one box is always coming up, while the other is going down, the numbers pointed at must be doubled, except the machine be made to act both ways, which will hardly be needful. As the machine is at present, though it points out a thousand boxes only, yet it will serve for two thousand.

The mechanism with very little variation, may be fixed to a horse-machine, called in some places a gin, viz. as a gin may be ten yards or more in circumference, the action would be too slow, if moved by an endless screw; a pinion with four leaves, will be found much more convenient. This pinion may be fixed to the end of the upper gudgeon, which enters the box containing the machinery As some accuracy is required to make such a pinion work well, and these machines are often coarsely constructed, it will be necessary only to make about one inch and a half of the end of the said gudgeon exactly round, namely, that part of it which goes through the bottom

of the box, and the other part may be fastened so, that it can give way to any remaining inaccuracy of the rest of the gudgeon. In a machine adapted for a gin, the first wheel, for example, might have sixty-four cogs, and this with a pinion of four leaves, would require sixteen revolutions of the gin, for one of the wheel. Allowing ten yards for the circumference of the gin, it will take one hundred and sixty yards of rope; and considering that the said wheel can nearly make two revolutions, and that the catch will still act only once, it will consequently act for a pit of three hundred yards deep, as well as for one of ten or twenty.

In a machine, designed by the Inventor for a gin, the three wheels where placed one on another, and the index divided, viz. the fifty on the second, and the 1000 on the third wheel. The wheels moved, and the two hands stood, which pointed out the numbers as exactly as the machine shown by the plate. Machines for hand-windlasses may be made in the very same manner, and would be more simple, though the difference is but small; viz. the box would require but one lid and lock, and the two smaller wheels would become unnecessary.

Though in setting the machine so as to begin counting with one, it may easily be effected by lifting out the spring, and then turning the wheel with the other hand, till both hands stand upon one; yet in the double index, the upper hand must only be set thus with the wheel, and the lower must be moved round on its socket.

It is not to a proprietor only that such a machine may be useful: it will save the honest banksman the trouble of noting down each box which is drawn up; but whether it may be chiefly designed for this use of preventing mistakes, or to the other of preventing fraud, it is necessary that the machine be so contrived that nothing essential to its accurate performance can be disengaged by accident or artifice. Hence it is intended to be inclosed in a box, without opening which, neither the endless screw can be disengaged from the wheel, nor the spring; nor can the number on the index be altered. For greater security, the box might be made of iron, and be provided with a good lock; otherwise, the stress is so small, that a wooden box would answer, if secured from the effects of the weather.

The machines designed for gins, the Inventor proposes to fasten to the beam in which the upper gudgeon turns. To effect this, the bottom of the box may have two projecting

ends with holes in them, larger than necessary to receive a strong pin or rivet: which pins must have large heads, so that when properly driven or riveted in, the box may be able to give way to any remaining inaccuracy in the lower parts of the gudgeon, as already mentioned. The machines designed for hand-windlasses, like the one represented by the plate, may be fixed to the side of the post in which one of the gudgeons turns; or they may be so contrived, that the gudgeon with the endless screw may be a piece by itself, attached only to the windlass by a square, or otherwise, as often practised in cotton-mills and other machinery.

The reference already made to the plate, having explained only the general principle of these machines, it will now be proper to advert more particularly to the several parts.

Fig. 1. A, the roller, with an endless screw, to be the size of the gudgeon of a hand-windlass.

B, the first wheel of forty teeth, with a brass catch C. It may be moved backwards or forwards by the endless screw.

D, a ratchet-wheel with fifty feet, which, when the wheel B is put in motion one way, the catch will slide over its teeth; but on turning it the other way, the catch will drop into and forward this wheel one tooth, in which situation it is prevented from returning by the spring E, placed on the side of the box which holds a tooth on the side of the wheel.

F, a small pinion of four teeth, on the back part of the axle of the wheel D. This pinion moves a large wheel on the other side of the box.

Fig. 2. G, the large wheel last mentioned; it has eighty teeth.

H, a smaller wheel of fifty teeth, fixed fast on the face of the wheel G; which wheel H works a wheel I, of the same number of teeth, shown by dotted lines, behind the figured dial-plate.

The short hand or finger of the dial, is placed upon an arbor or collar of this wheel I, and moves with it.

The long finger or hand of the dial-plate, goes upon a square on the end of the spindle on which the above arbor moves; which spindle moves forward this long finger one division in fifty of the outer circle marked on the dial-plate, every time the rope, or any thing attached to it, has been down to the bottom of the mine, and returned to the top.

The inner circle of the face of the dial is marked in divisions of fifty each. When, therefore, fifty draughts up and down have been made from the mine, the shorter hand will be found

if both hands were originally set correctly at the top, to have moved to the first interior division marked 50; and so on, in proportion, will advance as more draughts are made.

K is a board placed under the wheels BD, in fig. 1, and which separates them from the other wheel-work in fig. 2, where only a few teeth of the wheel B appear behind it.

LL, show the temporary handles in both figures; and the position of those letters denote that the gudgeon of the windlass, when the machine is in actual use, should be there joined to or make a part of the roller A.

Fig. 3 shows, on an enlarged scale, the form of the catch C. The steel spring M pressing against the pin N, returns the catch to the tooth of the wheel D, when it has been forced back: and a pin fixed underneath the catch moves in a groove O, made in the wheel B, to prevent the catch being pressed too far back, or thrown out improperly by the spring.

A door is fixed on each side of the box, and should be locked to prevent the hands from being improperly moved.

It will easily be perceived, that by enlarging the wheels, and increasing the number of their cogs, the number of yards required for the depth of a mine, as likewise the number of boxes to be pointed out in any given interval, may be carried to any desirable extent.

Machine for obtaining the Bevel of Wheels.

Fig. 4, plate XVI, represents the instrument for bevelling wheels, which may properly be called a bevelling quadrant; the graduated scale FB being the fourth part of a circle, and divided into 90 degrees from F to B.

ACB and DCE are the limbs of the quadrant, which move on the centre at C. The edges of the limbs ACB and DCE are each in a right line, and intersect each other exactly at the centre C, in order that the angles ACD and ECB may be equal.

The scale is attached to the end of the limb B, and slides through the end of the other limb at E, in a dove-tail, to which it can be fixed at pleasure by a small screw.

Bevelled wheels are generally such as run or work into one another, the one in a horizontal and the other in a vertical

position; or, whose axes are at right angles to each other; as the two wheels in figs. 5 and 6.

The bevels of the two wheels, running as above, are found by drawing a right line from the point B, fig. 5, or *b* fig. 6, where the centre-line of the axes intersect each other, (and which may be properly called their common centre of motion, to which all the teeth in both wheels must point,) to the extremity of the circumferences where the two wheels meet, as BD, and *b a*.

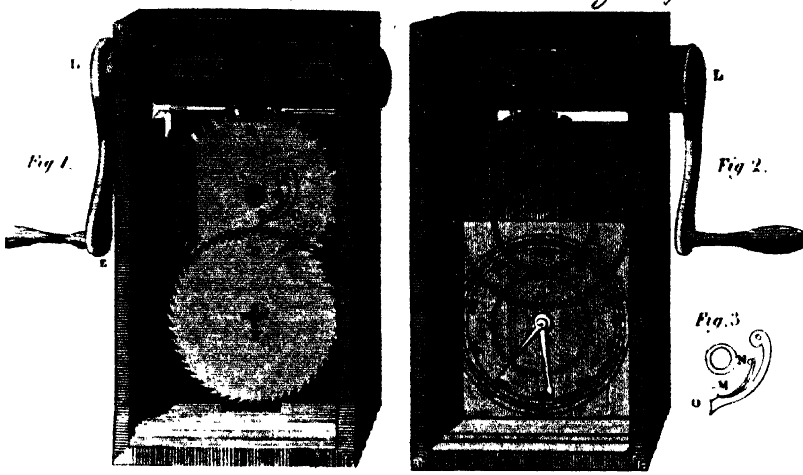
In fig. 5, where the two wheels have the same diameters, and the axes are at right angles, the bevel of the wheels, described by the line DB, will be equal each to an angle of 45 degrees, or half a right angle; for the sides and angles D, E, B, A, are equal; therefore the diagonal, or line DB, divides the right angles ADE and EBA into two equal parts.

The degree of bevel then is expressed by the angles described by the centre-line of the axis of the wheel, and the bevel line of the teeth DB falling upon it.

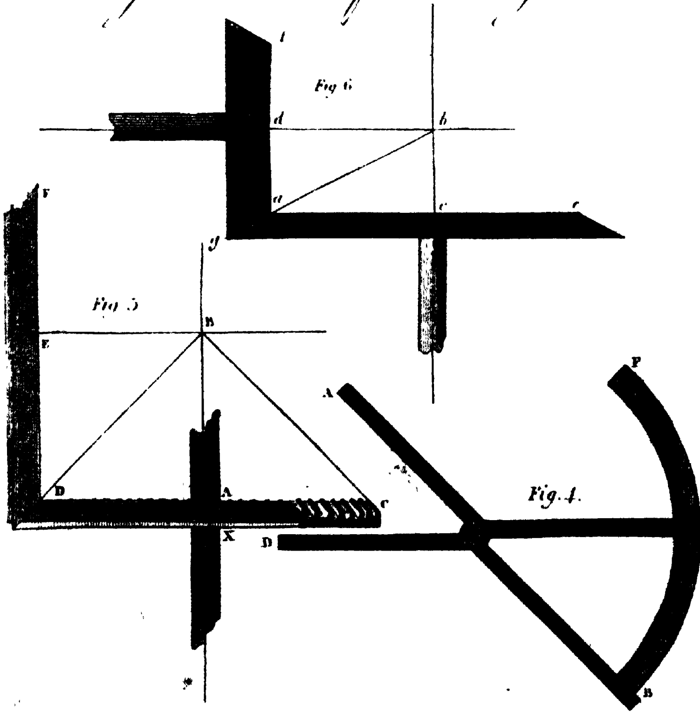
In fig. 6, the wheel *a c e* is twice the diameter of that marked *a d f*: to find their respective bevels from the point *b*, where the centre-line of the axes intersect each other, draw the line *b a* to the extremity of the wheels at *g*, as already noticed, which divides the parallelogram *c a d b* into two equal parts. But the base *a c*, of the angle *c b a*, is double the base *a d*, of the angle *d b a*; consequently the bevel of the large wheel *a c e*, is double the bevel of the small one *a d f*: therefore, the bevels of wheels are, to one another, as the differences of their diameters.

To ascertain, then, the bevels of any two wheels that are intended to pitch or run into each other, it is only necessary to know their diameters, or what is the number of teeth in each: then say, as the sum of their diameters, or teeth, is to 90 degrees, so is the diameter, or teeth, of each wheel, to its respective angle or bevel. Suppose, for example, one wheel of 40, and another of 20 teeth; then as $40 + 20 = 60 : 90 :: 40 : 60$. Again, as $60 : 90 :: 20 : 30$. The bevel of the wheel of 40 teeth then, by the above formula, is equal to an angle of 60 degrees, and the other of 30 degree; which, added together, is $= 90$ degrees. Or, having found the complement of one of the wheels, as above, subtract that from 90, and the remainder will be the complement of the bevel of the other. Where the axes of the wheels make either a greater or smaller angle than 90, take the complement of the angle which they describe for the middle term, in place of 90, and proceed, in

Antis's Indicator of the Number of Draughts from a Mi



Kelly's Instrument for Bevelling Wheels.



Published by Henry Fisher, Caxton, London, 1823

finding the respective bevels of the wheels, according to the formula exhibited above.

To use the Instrument.—Having found the bevel of the wheel of 40 teeth to be equal to an angle of 60 degrees, move the under edge of the limb E of the quadrant (fig. 4) to 60 on the scale, and then apply the upper edge of the limb D, to the under part or sole of the wheel at X, fig. 5, and the inner edge of the other limb A will describe the bevel that the wheel must be worked or formed to. Then, for the wheel of 20 teeth, set the quadrant to an angle of 30 degrees, and proceed in like manner with it, and so on for any other bevel. The bevel may be also expressed by the angle described by the sole or under part of the wheel and the line of the bevel of the teeth, as XCB, fig. 5; in which case, the bevels of two wheels, so expressed, will be to one another, in the inverse proportion of their diameters; and the quadrant will equally apply to the above-mentioned purpose, by numbering the divisions of the scale the contrary way, to that in the drawing.

The instrument here described, and the manner of using it, are so very simple, that almost any mechanic, employed in machinery, may both make and use it.

The instrument may be made either of wood or metal; and will be found particularly useful in bevelling small metal wheels, where the apparatus commonly used in bevelling large wheels cannot be applied.

Method of obtaining admirable Lakes from Madder.

Madder is well known to furnish a dye less subject to change by exposure to air, than any other vegetable colour. except indigo; yet till the following processes were published, no means were known of obtaining from it a red colour possessing the depth and transparency of the lakes made from cochineal. Several of the most eminent painters of this country had been in the habit of using madder lakes in oil pictures; but the colours they possessed under this name were either a yellowish red, nearly of the hue of brick dust, or a pale pink, opake and without clearness or depth of tint, and quite unfit to be used in water-colours. By the old recipes,

the best part of the colouring matter of this root, was in fact not extracted, and the produce was therefore imperfect. By the following new process, however, an admirable lake, will be obtained.

PROCESS FIRST.

Enclose two ounces, troy-weight, of the finest Dutch madder, known in commerce by the name of crop madder, in a bag, capable of containing three or four times the quantity, and made of strong and fine calico. Put it into a large marble or porcelain mortar, and pour on it about a pint of cold soft water. The Thames' water, when filtered, is as good as can be used; it being very nearly as pure as distilled water, at least when taken up a very little way above London. With a marble or porcelain pestle, press the bag strongly in every direction, and, as it were, rub and pound it as much as can be done without endangering the bag. The water will very soon be loaded with the colouring matter, so as to be quite opake and muddy. Pour off the water, and add another pint of fresh water to the root, agitating and triturating it in the manner before described; and repeat the operation till the water comes off the root very slightly tinged. About five pints of water, if well agitated and rubbed, will extract from the root nearly the whole of its colour; and if the residual root be taken out of the bag and dried, it will be found to weigh not more than five drachms, apothecaries' weight; its colour will be a kind of light nankeen, or cinnamon, and it will have entirely lost the peculiar ordour of the root, and only retain a faint woody smell.

The water, loaded with the colouring matter, must be put into an earthen vessel or well-tinned copper, or, what is still better, a silver vessel, (for the use of iron must be carefully avoided through the whole,) and heated till it just boils. It must then be poured into a large earthen or porcelain basin and an ounce troy-weight of alum dissolved in about a pint of boiling soft water, must be poured into it, and stirred until it is thoroughly mixed. About an ounce and a half of a saturated solution of mild vegetable alkali should be gently poured in, stirring the whole well all the time. A considerable effervescence will take place, and an immediate precipitation of the colour. The whole should be suffered to stand till cold, and the clear yellow liquor may then be poured off from the red precipitate. A quart of boiling soft water should again

be poured on it, and well stirred. When cool, the colour may be separated from the liquor by filtration through paper in the usual way; and boiling water should be poured on it in the filter, till it passes through of a light straw colour, and quite free from any alkaline taste. The colour may now be gently dried; and when quite dry, it will be found to weigh half an ounce; just a fourth part of the weight of madder employed.

By analysis, this colour possesses rather more than 40 per cent of alumine. If less than an ounce of alum be employed with two ounces of madder, the colour will be rather deeper: but if less than three-quarters of an ounce be used, the whole of the colouring matter will not be combined with alumine. On the whole, the proportion of an ounce of alum to two ounces of madder, will probably be found the best.

PROCESS SECOND.

If, when the solution of alum is added to the water loaded with the colouring matter of the root, the whole be suffered to stand, without the addition of the alkali, a considerable precipitation will take place, which will be of a dark dull red. The remaining liquor, if again heated, will, by the addition of the alkali, produce a rose-coloured precipitate of a beautiful tint, but wanting in force and depth of tone.

This is the process recommended by Watt, in his Essay on Madder, in the *Annales de Chymie, tome 7*; and the colour may perhaps with propriety be called Madder Lake. But although the lighter red may be excellent for many purposes, yet the colour produced by the union of the two colouring matters, as given in the first process, is preferable for general use, being of a very beautiful hue when used thin, and possessing unrivalled depth and richness either in oil or water, when laid on in greater body.

If but half an ounce of alum be added to the two ounces of the root, the first precipitate will be nearly similar to that when an ounce is employed; but the second, or lake precipitate, will be less in quantity, and of a deeper and richer tint. In this case, the whole of the colouring matter, as before observed, is certainly not combined with the alumine; for, on adding more alum to the remaining liquor, a precipitate is obtained of a light purplish red. In this process, when two ounces of madder and an ounce of alum are used, the first precipitate has about 20 per cent. of alumine, and the

second, or lake precipitate, about 53 per cent.; but these proportions will vary in repetitions of the process.

PROCESS THIRD.

If the madder, instead of being washed and triturated with cold water, as directed in the foregoing process, be treated in exactly the same manner with boiling water; the colour obtained will be rather darker, but scarcely of so good a tint; and the residuum of the root, however carefully pressed and washed, will retain a strong purplish hue; a full proof that some valuable colour is retained in it, probably fixed in the woody fibre by the action of heat. Watt, in his excellent Essay on Madder, above referred to, observes, that cold water extracts the colour better than hot water; there is, indeed, reason to suspect, that a porportion of the colouring matter, which produces the bright red pigment, distinguished before by the name of Madder Lake, remains attached to the root, when acted on by boiling water.

PROCESS FOURTH.

If to two ounces of madder, a pint of cold water be added, and the whole be suffered to stand for a few days, (three or four days,) in a wide-mouthed bottle, lightly corked, in a temperature of between 50° and 60°, and often shaken, a slight fermentation will take place; the infusion will acquire a vinous smell, and the mucilaginous part of the root will be in a great degree destroyed, and its yellow colour much lessened. If the whole be then poured into a calico bag, and the liquor be suffered to drain away without pressure, and then the root remaining in the bag be treated with cold water, &c. exactly as directed in the first process, the red colouring matter will quit the root with much greater ease than before fermentation. It will also be equal in quantity to that afforded by the first process, but of a much lighter red. This difference of tint appears to be owing to a destruction of a part of the lake by the fermentation of the root; for if the colours from the fermented root be obtained separate, as in the second process, the first precipitate will not sensibly differ from that obtained from the unfermented madder, but the second, or lake, will be of a very light pink. This process, then, is not

to be recommended, but the account of it is useful, as showing the effect of different modes of management.

SPANISH AND SMYRNA MADDERS.

Spanish madder affords a colour of rather a deeper tone than the Dutch madder, but it does not appear to be of so pure a red as the Zealand crop madder.

The Smyrna madder is a very valuable root. The colour produced from it, by process first, is remarkable for the richness and depth of its tint. The quantity produced from two ounces, is only three drachms, twenty-four grains; but this is not to be wondered at; for as this madder is imported in the entire root, in a dry state, and the crop madder of Zealand consists principally of the bark, in which probably the greatest part of the colouring substance resides, there is every reason to think that the Smyrna madder really contains a greater proportion of colour than the Zealand, in equal quantities of the entire root.

The products of process second prove, than the *lake* of the Smyrna madder is more abundant in quantity, and of a richer tone, than that of the Dutch root; for, from two ounces of Dutch madder, the first precipitate was two drachms, and the lake was two drachms and forty-eight grains; whereas, from two ounces of the Smyrna root, the first precipitate was one drachm and twenty-four grains, and the lake was two drachms and twenty-four grains. The proportion of the colour is, therefore, much higher in the Smyrna than in the Dutch root.

FRESH MADDER.

The colour may be prepared from the recent root; and it will be of a quality equal if not superior to any other. The fresh root is, however, not always to be obtained; with a small quantity of the best roots packed in moss from Holland, the following process answered perfectly well.

Eight ounces of the root having been first well washed and cleaned from dirt of all kinds, were broken into small pieces and pounded in a bell-metal mortar, with a wooden pestle, till reduced into a uniform paste. This paste being inclosed in a calico bag, was washed and triturated, as described in

the first process, with cold water. About five pints seemed to have extracted nearly the whole of the colour. To the water thus loaded with colour, and boiled as before, one ounce of alum dissolved in a pint of boiling water was added, and the alkali poured on the whole, till the taste of the mixture was just perceptibly alkaline. The colour thus obtained was of a very beautiful quality.

The success of this experiment, renders it probable that this mode of obtaining the colour from the fresh root, may be productive of extensive advantages. Many tracts of land, in this country, are as well adapted to the growth of this valuable article, as the soil of Holland can be; and the cultivation of it, which has more than once been attempted to a considerable extent, has been laid aside, principally from the expense attendant on the erection of drying-houses and mills, and the great expense and nicety requisite for conducting the process of drying. But should the colour prepared in the mode just described, be found to answer the purposes of the dyers and calico-printers, the process is so easy, and the apparatus required for it so little expensive, that any grower of the root might extract the colour; besides which, another great advantage would be obtained; the colour thus separated from the root, may be kept any length of time, without danger of spoiling, and its carriage would be only one-fourth of that of the root. And as it is probable that the dyers, according to the customary mode of using the root, leave in it a very considerable part of the colour,* there seems reason to conclude, that more important advantages than have yet been adverted to, may arise from the process here recommended.

Should it be attempted to obtain the colour from the fresh root, on an extensive scale, the roots duly washed, might be reduced to as uniform a pulp as possible, by grinding or pounding. To this purpose, it is probable, that the cyder-mill would answer perfectly well; and its extreme simplicity is a great recommendation. For the purpose of trituration, bags of woollen, such as are used in the oil-mills, would probably answer as well as calico, and they would be much cheaper and more durable. A large vat, with stampers, would be easily constructed, for holding and pressing them and water; and when the colour was boiled and precipitated, the flues of the boilers might easily be formed into convenient drying-tables, without any additional expense of fuel.

The author of these processes, considers the essential advantage of them, to consist in the trituration or pressing of

the root in cold water; and it appeared to him that the colouring matter of the root had not, previous to his investigations, been considered so nearly insoluble in water, as he found it to be.

Method of obviating the necessity of lifting Ships.

The invention of suspending, instead of lifting ships, for the purpose of clearing them from their blocks, is attended with great advantages. From the saving of time alone, which amounts to two-thirds, is derived the important advantage of enabling large ships to be docked, suspended, and undocked, the same spring tides. Without enumerating the inconveniences arising, and perhaps injuries ships are liable to sustain from the practice of lifting, and which are removed by the plan now proposed, that which relates to manual labour deserves particular attention; twenty men being sufficient to suspend a first-rate, whereas it would require upwards of 500 to lift her. The situation which the Inventor of the plan of suspension held in Plymouth yard, attached to him, in a great degree, the shoring and lifting of ships, as well as other practical parts of the profession of a shipwright. Here he had an opportunity of observing, and indeed it was a subject of general regret, how much time, expense, and labour, were required in lifting ships, particularly those of the line. This induced him to consider whether some contrivance could not be adopted to obviate these evils; and it occurred to him, that if he could so construct the blocks on which the ship rests, that the weight of the ship might be applied to assist in the operation, he should accomplish this very desirable end. In September, 1800, the shoring and lifting of the San Josef, a large Spanish first-rate, then in the dock at Plymouth, was committed to his directions; to perform which, the assistance of the principal part of the artificers of the yard was requisite. In conducting this business, the plan, which will be hereafter described, occurred to him; and from that time, he by various experiments, proved his theory to be correct: the blocks constructed by him, upon which the ship rests, being so contrived, that the facility in removing them is proportioned to the quantity of pressure; and this circumstance is always absolutely under

command, by increasing or diminishing the angle of three wedges, which constitute one of the blocks; two of which are horizontal, and one vertical. By enlarging the angle of the horizontal wedges, the vertical wedge becomes of consequence more acute; and its power is so increased, that it has a greater tendency to displace the horizontal wedges. By way of experiment, three blocks were made of hard wood, and the wedges of various angles. The horizonal wedges of the first block were nine degrees; of the second, seven; and of the third, five; of course, the angle of the vertical wedge of the first block was 162 degrees; of the second, 166; and of the third, 170. These blocks, or wedges, were well executed, and rubbed over with soft soap. They were then placed in a dock, in the King's yard at Plymouth, in which a sloop of war was to be docked; on examining them after the vessel was in, and the water gone, they were all found to have kept their situations, as placed before the ship rested upon them. Shores in their wake were then erected to sustain the ship, prior to the said blocks being taken from under the keel. The process of clearing them was, by applying the power of battering-rams to the sides of the outer ends of the horizontal wedges; alternate blows being given fore and aft; by which means they immediately receded, and the vertical wedges were disengaged. It was observed, even in this small ship, that the block which was formed of horizontal wedges of nine degrees, came away much easier than those of seven, and the one of seven, than that of five. In removing these blocks by the power of the battering-rams, which were suspended in the hands of the men employed, by their holding ropes passed through holes for that purpose, the operation was very laborious to the people; they having to support the weight of the battering-rams, as well as to set them in motion. The Inventor then conceived the idea of affixing wheels near the extremity of that part of the rams, which strikes the wedges. This was done before the blocks were again placed; and it has since been found fully to answer the purpose intended, particularly in returning the horizontal wedges to their original situations, when the work is performed for which they were displaced; the wheels also giving a greater increase of power to the rams, and decrease of labour to the artificers; besides which, the blows are given with much more exactness. The same blocks were again laid in another dock, in which a two-decked ship of the line was docked. On examination, they were found to be very severely pressed, but were removed with great

ease. They were again placed in another dock in which a three-decked ship of the line was docked. This ship having in her foremast and bowsprit, the blocks were put quite forward, that being the part which presses them with the greatest force. As soon as the water was out of the dock, it was observed, that the horizontal wedges of nine and seven degrees had receded some feet from their original situations. This afforded a satisfactory proof, which experience has since demonstrated, (though many persons before would not admit of, and others could not understand, the principle,) that the facility of removing the blocks or wedges, was proportionate to the quantity of pressure upon them. The block of five degrees kept its place, but was immediately cleared by applying the power of the battering-rams to the sides of the outer ends of the horizontal wedges. The above experiments being communicated to the Navy Board, the Inventor was directed to attend them, and explain the principle of his invention; which explanation, farther corroborated by proper testimonials, was so satisfactory, that a dock was ordered to be fitted at Plymouth, under his immediate directions. The horizontal wedges in this and in the other docks, that were afterwards fitted by him, are of cast iron, with an angle of about five degrees and a half, which, from repeated trials, are found equal to any pressure, having in no instance receded, and, when required, were easily removed. The vertical wedge is of wood, lined with a plate of wrought iron, half an inch thick. On the bottom of the dock, in the wake of each block, is a plate of iron three quarters of an inch thick, so that iron at all times acts in contact with iron.

The dock being prepared at Plymouth, in August, 1801, the Canopus, a large French 80-gun ship, was taken in and rested upon the blocks; and the complete success of the experiment was such, that other docks were ordered to be fitted at Sheerness and Portsmouth dock-yards, under the Inventor's directions. At the former place, a frigate, and at the latter, a three-decked ship, were suspended in like manner. This was in December, 1802, and January, 1803; and the reports were so favourable, that directions were given for the general adoption of these blocks in the King's yards.

The time required to disengage each block, is from one to three minutes after the shores are placed; and a first-rate sits on about fifty blocks. Various are the causes for which a ship may be required to be cleared from her blocks, viz. to shift the main keel; to supply a false keel; to repair defects;

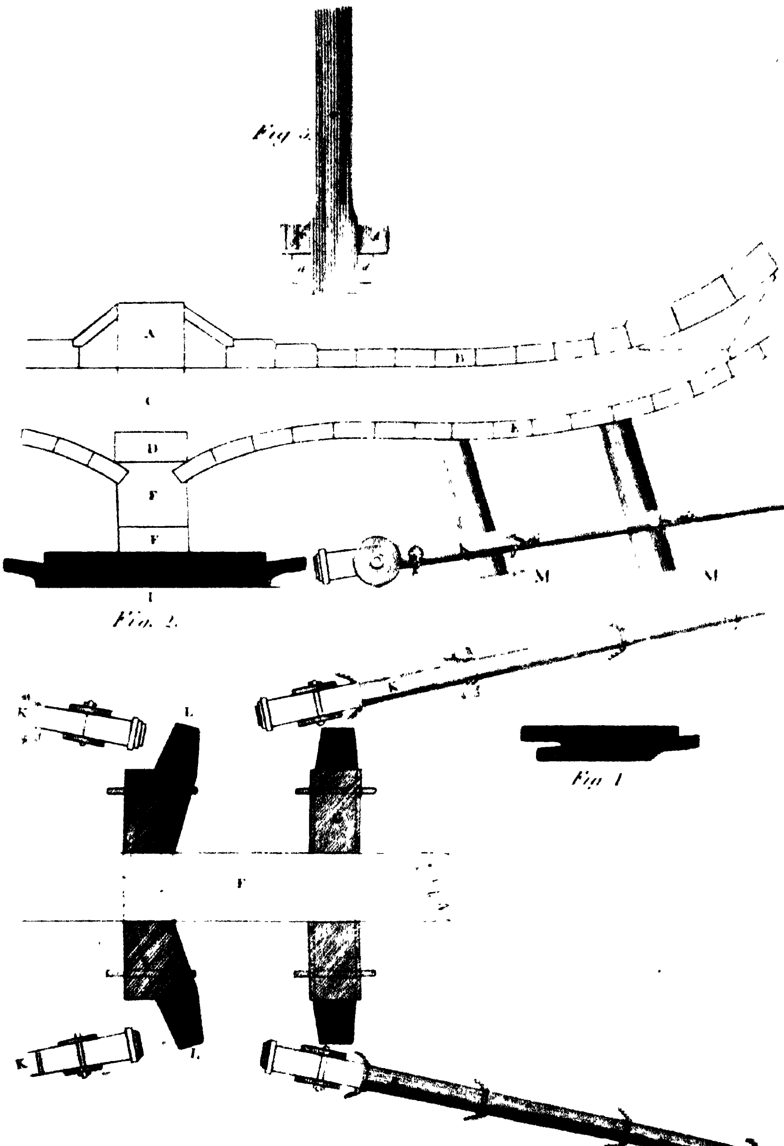
to calk the garboard seams, scarples of the keel, &c. Imperfections in the false keel, which are so very injurious to the cables, can in the largest ship be remedied in a few hours, by this invention, without adding an additional shore, by taking away blocks forward, amid-ships, and abaft, at the same time; and when the keel is repaired in the wake of those blocks, by returning them into their places, and then by taking out the next, and so on in succession. The blocks can be replaced in their original situations, by the application of the wheel battering-rams to the wedges, the power of which is so very great, that the weight of the ship can be taken from the shores that were placed to sustain her.

This invention may be applied with great advantage, whenever it is necessary to erect shores, to support any great weights, as, for instance, to prop up a building, during the repair of its foundation, &c. Captain Wells used these wedges for a fid of a top-gallant mast of his ship, the Glory, of 98 guns; and for this and other ships, the wedge-fids have been found in every respect to answer.

When it is required to strike a top-gallant mast, the top ropes are hove tight, and the pin which keeps the horizontal wedges in their place, is taken out, by one man going aloft for that purpose; the other horizontal wedge is worked in the fid, as shown in the plate. The upper part of the fid-hole is cut to form the vertical wedge. The advantage derived from fidding top-gallant masts in this way is, that they can be struck at the shortest notice, and without slackening the rigging, which is frequently the cause of springing and carrying them away, particularly those with long pole heads. The angle of the horizontal wedges for the fids of masts should be about twenty degrees.

The plan and section, plate XVII, shows the method of obviating the necessity of lifting ships, when there may be occasion to put additional false keels to them, or to make good the imperfections of those already on; also when it may be necessary to calk the garboard seams, scarples of the keel, &c. by which means a very considerable part of the expense will be saved, and much time gained. The blocks are cleared, and again returned by the following process: — A sufficient number of shores are placed under the ship to sustain her weight, and set taught, stationed as near the keel as the working of the battering-rams, fore and aft, will admit. Avoid placing any opposite the blocks, as they would in that case hinder the return of the wedges with the battering-rams.

Seppings' Method of lifting Ships.



Scale of ¼ of an Inch to a Foot.

Published by Henry Fisher, Caxton, London 18[illegible]

A blow must then be given forward on the outer end of the iron wedges with the battering-rams in a fore and aft direction, which will cause them to slide aft, as shown in the plan. The battering-rams abaft then return the blow, and the wedges again come forward; by the repetition of this operation, the wedges will be with great ease cleared, and the angular block on the top will drop down. When the work is performed, the block must be replaced under the keel, and the wedges driven back by working the rams athwart ships, as described in the section.

In returning the iron wedges, to avoid straining the angular blocks, it is proposed to leave a few of them out forward and aft, and stop the ship up, by laying one iron wedge on the other, as shown by fig. 1.

To facilitate the business, blocks may be cleared forward and aft at the same time, sufficiently to place one length of false keel. If the false keel should want repairing, it may be done without any additional shores, by clearing one block at a time, and when the keel is repaired in the wake of that block, return the wedges as above directed, and clear the next, &c.

In the section and plan, fig. 2, A is the keelson.

B, the ceiling.

C, floor-timber.

D, dead or rising wood.

E, plank of the bottom.

F, keel and false keel.

G, angular blocks, with a half-inch iron plate bolted to them.

H, cast iron wedges.

I, iron plate of three-fourths of an inch thick, on the bottom of the dock.

K, battering-rams, with wheels, and ropes for the hands.

L, cast iron wedges, having received a blow from forward.

M, shores under the ship to sustain her weight.

Fig. 3, represents part of a top-gallant mast fitted with a wedge-fid.

a, top-gallant mast.

b, fid, with one horizontal wedge worked on it.

c, moveable wedge, with the iron strap and pin over it, to keep it in its situation.

d, trussel trees.

Description of a Stove, on the Principles of the Swedish Fire-place, with Heat-openings.

The true principles of constructing fire-places, so as to obtain the greatest heat with the least consumption of fuel, have been known for some time: but they have been much less generally adopted, than the necessity for economising fuel demands. We see many fire-places so deep, as to consume double the quantity of fuel necessary, and yet heat the apartment but faintly, where half the expense might be spared by altering the fire-place according to Count Rumford's plan.

If a chimney smoke, instead of reducing the tunnel to proper dimensions, so that descending currents cannot take place in it, scarcely any remedy is thought of but air-holes, which require the sacrifice of a certain quantity of fuel, to counterbalance the effect of the cold continually entering.

The use of the Swedish stoves, is scarcely known in the southern part of Europe, probably from their not having been constructed on just principles, or in the best proportions, at their first introduction. But the Author of this essay having had one made which appeared to many of his friends to produce an astonishing effect, in compliance with their request, he has undertaken to give an exact description of it, premising a few principles, with regard to fires:

1. The heat produced, is proportionate only to the air consumed by the fuel.

2. The quantity of heat produced by a given quantity of fuel, is greatest when the combustion is most complete.

3. The combustion is most complete when the combustible part of the fuel is retained longest in pipes in which it may undergo a second combustion.

4. Of the heat produced, none is of use, but what is diffused through the space to be heated, and retained in this space.

5. The temperature in this space will be higher, in proportion as the current of air, which is to renew and keep up the combustion, is less disposed to absorb the heat of this space in passing through it.

Hence are deducible the following obvious consequences:

1. The fire-place must be kept separate from all bodies that conduct heat rapidly.

2. As heat can be produced only by combustion, and combustion can be maintained only by a current of air, this current should be directed into pipes, where it preserves the requisite velocity, without escaping from the place to be heated, so that the heat it deposits in it, gradually accumulates in the whole of the isolated stove, to be afterwards given out slowly, according to the laws of its equilibrium.

3. When the wood* is consumed to such a point as to afford no more smoke it is of advantage to stop the outlets of these pipes, to keep in the heat that would be carried into the chimney by the continued current of fresh air, which would necessarily be of a lower temperature.

4. We shall obtain a higher temperature, and preserve it longer under similar circumstances, if we construct within the stove, or under the hearth and round the fire-place, pipes in which the air derived from without, is warmed before it enters into the apartment to support the fire, or to replace what has been consumed.

These pipes are what have been called heat-openings, because, instead of considering their principal object, it is commonly supposed that they are made to give a more rapid passage to the heat produced. This is not totally without foundation, since the temperature of the air issuing from them is increased by the heat it absorbs from the stove; and on this account some might be disposed to neglect them, as contrary to the most essential object, that of retaining the heat in it; but it is to be observed, that we can shut these outlets when we please; and that we may even cut off all communication with the external air, by means of a simple slider; so that every advantage may be derived from them without any inconvenience. It must be added, that they are necessary in very close apartments, unless we would expose ourselves to currents of cold air. These reasons show the advantage of employing the heat-openings in the Swedish stove, to which they have not hitherto been applied.

The Swedish stoves are constructed according to the most correct principles, and the pipes in which the smoke circulates, are disposed in the best manner for effecting its complete combustion. Their utility has been found so great, that they have become general in Sweden, where the winters are very severe,

* In this essay, wood is the fuel particularly named, because it was written in France, where no other fuel is general.

and where they have diminished the consumption of wood one-third, so that there is no country where inclemency of weather is guarded against at less expense. They have likewise been employed advantageously, with the necessary variations of form, in dyehouses, breweries, &c.

Their construction is by no means expensive; they save iron-work, and require only bricks or tiles. These are recommended to be placed edgewise, and chosen as thin as possible for the inner walls. The circulating pipes are to be placed so, that rain falling down the chimney can never get into them. The method of using them is so easy, that in the largest public buildings one person is sufficient to light all the fires. All the wood that can be contained in the fire-place, which is very small, is to be put in at once; it is to be sawn into pieces of equal lengths, and as soon as it is burned, the slider that stops the communication of the circulating pipes with the chimney is to be thrust in. By these means, all the heat, which the fuel is capable of producing, remains in the pipes, and issues out slowly, and only to diffuse itself in the apartment; while a single piece of wood that had not burned at the same time with the rest, would oblige the slider to be left open, and the current of air necessary for its combustion, would carry off into the chimney the greater part of the heat produced.

The following is a description of the stove constructed according to the Author's directions:

Fig. 1, plate XVIII, represents a front view of the stove; its height is 164 centimetres, (about 64½ inches English,) exclusive of the vase, which is a separate ornament, merely placed on the top.

Its breadth is 85 centimetres, (about $33\frac{4}{10}$ inches.)

Its depth 58 centimetres, (about $22\frac{8}{10}$ inches.)

The height may vary according to the size of the apartment, and may be extended without inconvenience to two metres, (about 6 feet 6¾ inches;) or may be reduced so as not to exceed one-third of that height.

The other two dimensions are determined by those of the bricks employed to form the interior circulatory pipes, which should be in certain proportions, that the smoke may pass through them freely, without so much air entering with it as would condense it, or sink the temperature below the degree necessary in combustion.

VV are the external parts of the two heat-openings.

m m, Apertures of the stove, by which the air, that is to

issue through the heat-openings, enters. These are closed, when the air is drawn from without, through a pipe passing under the floor; which is much more advantageous for renewing the respirable air of the apartment, and prevents the danger of currents of cold air, attracted by the fire; the supply of air through a pipe is necessary, whenever the volume of air in the apartment is not sufficient both for the consumption of the fire, and the circulation in the heat-pipes.

Fig. 2, is a plan of the foundation of the hearth, at the height of the line AB, fig. 1. *l l* are empty spaces, to receive the air, and convey it into the compartments, where it is to be heated before it issues by the heat-openings, whether the air be obtained from without, or simply by the apertures *m m*, fig. 1.

Fig. 3, is a plan at the height of the line CD, fig. 1; *n n n n*, are the double plates of cast iron, forming the compartments in which the air is to receive the effect of the heat of the fire. *o o*, the empty space between these plates.

Fig. 4, a front section at the line IK, fig. 3. The arrows indicate the direction of the smoke in the circulatory pipes of the front part.* In this section, the plates of iron *n n* are seen in their perpendicular situation, with the tongues which form their compartments on each side of the fire-place. One of these plates is represented in front, fig. 7.

T, is an opening left at the bottom of the fourth circulatory pipe, to restore the draught of air in the fire-place, if necessary, by burning there a few slips of paper, or other light combustible. The remark, *if necessary*, is inserted, because this precaution may be neglected, as soon as the stove has been heated so as to have lost all its internal dampness.

The door of this sort of blower or air-vent, ought to shut very close. For this purpose it is sufficient, to cut a piece of brick of the proper size, to make a hole in it to receive a handle, and to fasten upon it a piece of sheet iron, projecting a little all round it.

Fig. 5, a plan at the height of the line EF, fig. 1.

---

* Among the number of Swedish stoves described and delineated in the collection published by Baron Cronstedt, there are several, the circulating pipes of which pass under the hearth. This gives them a little more extent, no doubt, but as soon as the hearth is covered with ashes, the air passing beneath can receive but a very slight impression of heat; it obliges the fire-place to be raised higher; and it renders the construction more complex and expensive. For these reasons it is not brought forward here.

Fig. 6, a transverse section at the line GH, of fig. 3; it shows the height of the fire-place, and the first direction of the flame.

V points out the arrangement of the heat-pipes.

The dotted lines give the profile of the party walls, which form the four grand circulatory pipes.

R the pipe which conveys the smoke from the circulatory pipes into the chimney, and in which is the register that cuts off the communication. It is a common stove tunnel of plate iron; but it would be better to use a substance more slowly conducting heat, as an earthen tube made on purpose, for that part in which the slider or stop-plate acts.

The elbow made by this pipe to reach the chimney, renders it unnecessary to repeat, that it is a point of the first importance for the body of the stove to be completely separate from the wall. The one described, is 25 centimetres (nearly 10 inches) distant from the nearest point of the niche in which it is placed.

S is an elongation of the perpendicular pipe that enters into the chimney. It is intended to receive the water that might condense in the upper part, and which it prevents from getting into the stove. Its aperture is covered by a cap, which is easily removed, and allows the pipe to be cleaned, without taking it down.

The dotted lines forming the square space Q, mark a place where a niche may be made, or a sort of little stove, as is done in some of the Swedish stoves, and would advantageously supply the place of the brick-work, with which it must otherwise be filled up.

All these figures being drawn to the same scale, there will be no difficulty in preserving the proportions of the parts.

The construction of this stove is neither difficult nor expensive. For the outside, nothing is wanted but Dutch tiles, such as are used for common stoves, that is to say, thin in the middle, and having a border all round, which serves to give them more stability. They are fixed in like manner, by a band of metal. The hind part may consist entirely of bricks. The vase placed on the slab of marble or stone, which covers the stove, is a mere ornament.

If it be thought proper to have no heat-openings, all the interior structure may be made of bricks of proper sizes, laid with loamy earth moistened, and set on edge for the circulatory pipes, without any iron, except a cast plate over the fire-place, and a door and frame in the usual manner.

The expense of the heat-openings, however, consists only in four cast iron plates with tongues and grooves to form the compartments represented at fig. 7. All the rest is done with plate-iron, bent round and rivetted, which, when once enclosed in the masonry, will not admit the escape of the air.

Cast iron plates with grooves are well known, since Franklin's stoves have been adopted. If it were found difficult to procure them, their place might be supplied in two ways. First, by portions of pipes of cast iron, which might be placed vertically side by side, serving as the inside walls of the fire-place, and communicating with each other by little channels at the top and bottom, formed in the masonry. Secondly, by common plain cast plates, soft enough to admit of being bored, so as to rivet on bent slips of plate iron, which would perfectly answer the purpose of the tongues and grooves. As these would never be exposed to the action of the flame, there is no reason to fear their casting. The latter of these two methods is obviously the most advantageous, as it occupies less room, and yet affords more surface to receive the action of the heat, and communicate it to the circulating air.

In concluding this description of the stove, the Author observes, that nearly two years' experience has convinced him of the good effects of its proportions.

It is placed in a room fronting the north, the floor of which measures 47 metres square, (about 154½ feet,) and which is 42.5 decimetres (nearly 14 feet) high. Every day a log of wood, 28 or 30 centimetres (10 or 11 inches) round, sawn into three pieces, or an equal quantity of smaller wood, is burned in it at once. The slider of the door of the fire-place is shut, and the key, R, fig. 6, is turned, as soon as the wood is reduced to charcoal. Ten hours after, the air throughout the room is at a temperature above the mean; and the centigrade thermometer, placed 36 centimetres (above 13 inches) from the stove, rises rapidly to 16° or 17°, (60° or 62° of Fahrenheit.)

To show still more plainly to what degree the economy of fuel and preservation of heat may be carried by this construction, the following experiment may be related; it was repeated on several occasions, and always with nearly the same results:

The thermometer in the room, in which there was no fire the day before, being between 9° and 10°, (48° and 50° of Fahrenheit,) a log, sawn as usual in three, was put into the fire-place about eleven in the morning; and at three in the

afternoon, a similar quantity of fuel was put in. The thermometer, placed at the distance above-mentioned, was,

	Degrees.		Degrees.	
At four o'clock, at	42*	=	107	of Fahrenheit.
At five	37	=	98	,,
At seven	34	=	93	,,
At nine	31	=	87	,,
At midnight	26	=	78	,,

The iron rim of the heat-openings could not be touched with the hand. The bulb of the thermometer being placed opposite one of these openings, at the distance of 8 centimetres (above 3 inches) rose in four minutes to 35°, (95° of Fahrenheit.)

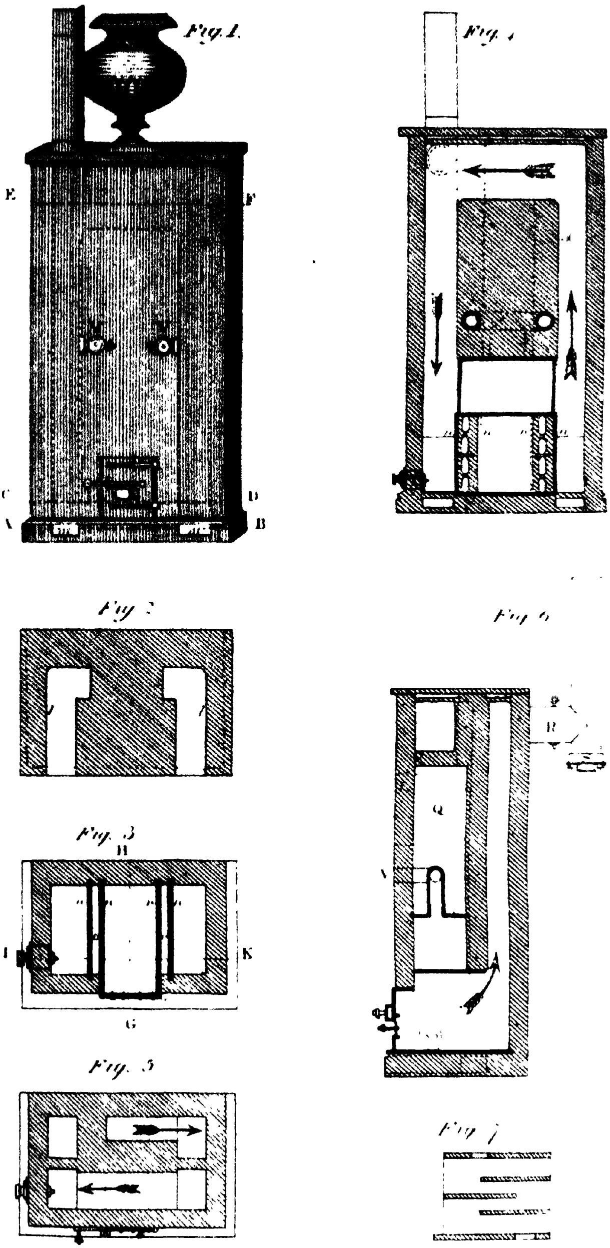
The next morning, at nine o'clock, the thermometer, which had been again placed at the distance of 35 centimetres, (nearly 14 inches,) was at 22°, (71° F.)

Finally, at noon, that is to say, twenty-one hours after the last wood was put in, and eighteen hours after the key had been turned, all the wood being reduced to charcoal, the thermometer stood between 18° and 19°, (64° and 66° F.) It was then placed two centimetres only from one of the heat-openings, and in less than six minutes it rose to 26°, (78° F.)

These effects are so different from what we commonly obtain by the consumption of three or four times as much fuel, that the Author expects more than one reader will suppose them exaggerated; but he hopes a sufficient number will be found to make a trial of these stoves, that their testimony and example may at length triumph over our habits, and produce a general conviction, that, without suffering any privation, we may preserve from useless waste an article of the first necessity.

* The degrees mentioned here are those of the centigrade thermometer, the use of which is as general in France as that of Fahrenheit is in England. The centigrade thermometer is sometimes called Celsius's thermometer. It may be useful to observe, although the calculation in each instance is rendered unnecessary on the present occasion, that its degrees will be reduced to those of Fahrenheit, if multiplied by 1.8, and the product increased by the addition of number 32: thus $42 \times 1.8 + 32 = 107.6$, which are the degrees of Fahrenheit equivalent to 42° of the centigrade thermometer; the remainder, .6 this, is rejected in the statement above, as it is immaterial in the present essay.

Guyton's economical Stove



Construction of a Stove for drying Goods.

Having given the method of heating rooms by steam, and the construction of the Swedish stove, we might, perhaps, in this work have passed over any other invention for obtaining an artificial temperature, either as not necessary, or as already tolerably well known; but as the subject is important, we believe the following article will be acceptable, and that, though it might have been explained by way of supplement to the preceding paper, it will be more useful to give it entire.

This stove is described by its Inventor as suitable for the various purposes of heating, boiling, steaming, evoporating, drying, ventilating, &c. Fig. 1, plate XIX, represents a longitudinal section of it, showing the course of the air from its entrance into the flues of the stove at A, to its entrance into the upper chamber of the stove at B: and also the course of the smoke from the fire-place at C, till it escapes from the stove at D. EE, are the doors or openings of the fire-place and ash-hole.

Fig. 2, is a similar section at right angles with the above, exhibiting the course of the air through the chambers of the stove, from its entrance into the chamber No. 1, at B, to its entrance beneath the fire-place at F. This figure also shows sections of the flues, with the divisions, through which the air and smoke pass separately, the smoke flue in the centre, and the air flues on each side. GG, are doors and openings through which the articles to be dried are introduced into the chambers.

When the fire is lighted, and the doors of the chambers, ash-hole, and fire-place, closed, the air by which the fire is supplied enters at A, fig. 1, passes through the air-flues *a, a, a, a,* enters the upper chamber at B, traverses and descends through the chambers No. 1, 2, 3, and arrives beneath the fire at F, fig. 2. Having supplied the fire with oxygen, it passes through the flue with the smoke, and escapes at D, heating in its protracted course the chambers and air-flues.

As the cold air enters the stove at A, immediately above a plate forming the top of the fire-place, and pursues a similar route with the fire-flue, it enters the chambers very much heated and rarefied. Hence any moist substance placed in the chambers evaporates, in consequence not only of the heated flues circulating round them, but of a stream of warm rarefied air, which, while it continually raises evaporation, as continually bears away the exhaled moisture in its passage to the

fire, thus imitating the gradual and efficacious plan of nature in drying by the sun and air. While these effects are taking place within the stove, part of the air which enters at A, figs. 1 and 2, passes through air-flues on the other side of the fire-flue, pursues a parallel course with the first, and gives out a current of warm air to the room at an aperture H. This effect may be obtained in a much higher degree, if the doors of the chambers and ash-hole are opened; should the hand or face be then brought near, they would be fanned with a stream of warm air, especially from the upper chamber.

By means of this stove the inventor evaporated milk to dryness, without burning it or discolouring it; and dried cherries, plums, and other fruits, so as to imitate those which are received from abroad. He also repeatedly dried colours and the most delicate substances, without the slightest injury to them, even though the operation proceeded quickly.

The height of the stove is about 5½ feet; its diameter 2½ feet, and that of the flues 4 inches. The external part is constructed of brick, and the internal parts of thin Ryegate or fire stone, except the top of the fire-place, which is a plate of cast iron. Were it to be wholly formed of iron, its effects would necessarily be more powerful.

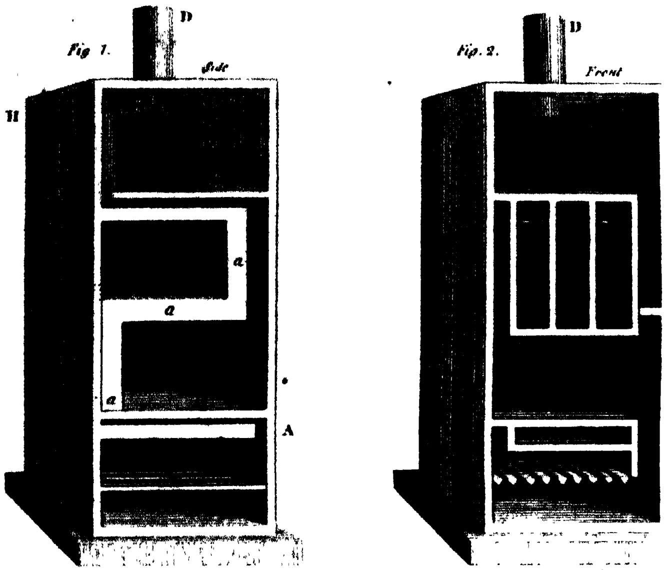
Fig. 3, represents an extension of the plan, in which stoves of this kind may be advantageously connected with one or more furnaces for chemical or other uses. The fire-place, brought out, either in front or on one side, by the present position of its crown I, forms a reverberatory furnace, or will make a sand-bath by reversing it.

The space occupied by the fire-place in fig. 1, may in this be converted into apartments for evaporating substances, or occasionally for cooling them by an opening at K to admit cold air, while the warm air of the stove is excluded by a register or door. The dotted lines show the manner in which a second furnace may be connected by an opening into the flue at L.

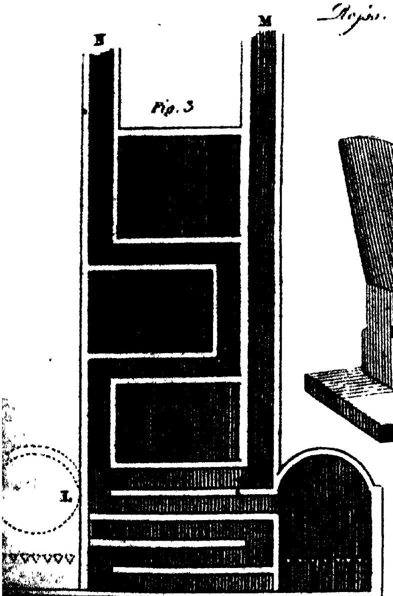
In addition to the uses already pointed out, this stove would probably be found extremely serviceable in drying japanners' goods, and consuming the noxious fumes and gas which arise from the oil and varnish used in this business.

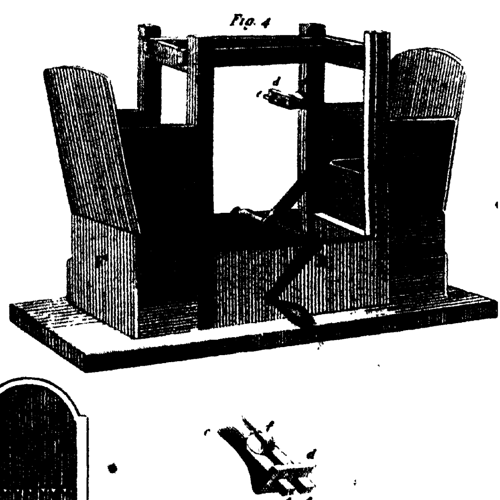
Since the stove is not limited to any certain dimensions, it might be adapted to the drying of malt and hops, perhaps of herbs, corn, and seeds generally. It might also be accommodated to the purposes of the sugar-bakers, connected with the great fires they employ for their boilers. It has been

[illegible] Stove for Heating and Drying



Rogers' Machine for separating Iron Filings from those of Brass &c.





Published by Henry Fisher, Caxton, London, 1823.

shown to be useful in the confectioner's art, and probably it may be equally so in baking biscuits for the navy; nor less so in drying linen for the laundress, dyer, calico-printer, and bleacher. The Inventor himself found it well accommodated for a chemical elaboratory.

The efficacy of the stove in ventilating, boiling, and steaming may easily be shown. In manufactories and rooms generally, the heated and noxious part of the atmosphere ascends towards the ceiling: if then the air-flue M, fig. 3, is continued upward according to the height of the room in which it is placed, the air will be drawn from the top, and the room become ventilated, while from the opening at N it is supplied, if requisite, with warm air.

It is unnecessary to show the various ways in which a boiler may be connected with this plan: it is sufficient to observe, that in the space allotted for the fire-place in fig. 1, there is sufficient room within the body of the stove for this purpose; and that if the circulating air be made to pass over the boiler, evaporation may be carried on very expeditiously by the air removing the vapour as it rises. Finally, if another division of the flues be made in the manner shown by fig.2, it might form a steam-pipe or flues, running the course of the air, and fire-flues to convey steam to one or more apartments of the stove; or extended beyond the stove for heating the room in which it stands. One of the air-flues might occasionally be adapted to this use. It is obvious that the power of steam in a heated apartment, would be not only greater, but better kept up. In steaming, it would be necessary to close the apartments of the stove, and to give air to the fuel by a different course.

As the stove is not confined in its dimensions, so neither is it necessarily of the form described in the drawing, nor are the apartments necessarily three: all these particulars admit of variation according to local or other circumstances. It is evident that the air-flues themselves may be converted into chambers for drying, &c.; and the fire-place of fig. 3, is well adapted to receive an apparatus for the decomposition of coal, &c.; for producing all the effects of the thermo-lamp, or illuminated smoke, &c. But it is needless to enumerate the many economical and philosophical uses to which the stove may be applied. It is sufficient for the present purpose, if the principle and plan be rendered intelligible, so that the artist and manufacturer may be at no loss in adapting it to the particular object, which he may require it to accomplish.

Method of boring the Conical Part of Brass Cocks.

It is extremely difficult, with any common apparatus, to bore accurately the conical part of brass cocks, especially when the water-way is cast in them. This circumstance suggested to the Inventor of the following plan, the necessity of a method of manufacturing these goods with more facility than had hitherto been practised; and he at length constructed the following apparatus, with which the cones may be bored with as much ease and accuracy as cylindrical bores of any calibre. At any time, it can be applied to a common lathe, with little loss of time, and may be worked by an ignorant person.

The additions necessary to be made to the common lathe, for this kind of work, will be understood by the following references to plate XX.

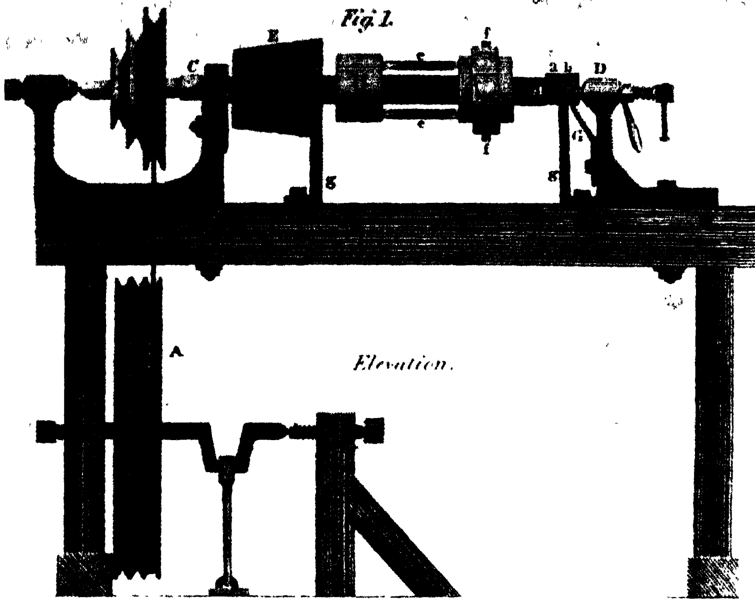
A, figures 1 and 2, is the foot-wheel of the lathe; B the cheeks, C the mandrel, and D the front puppet.

The piece of work in which the conical aperture is to be bored, E, is fixed on a screw at the end of the mandrel, so as to revolve with it in the usual manner of turning; a small pin is screwed into the end of the mandrel, as shown in the plan, fig. 2, which has a spherical head, and is received into a suitable cavity in the end of a square iron bar F, which is of sufficient length to extend to the front puppet D; at this end it has a sort of crutch or cross head, *a b*, composed of two pieces lying parallel to each other, and united by two screw-bolts, which being fitted into oblong holes, admit a small lateral motion of the pieces *b*, by the side of *a*; but they can be firmly held together by drawing the bolts tight.

The piece *a* is formed from the same piece of steel as the bar F; and the other, *b*, has several holes bored in the far side of it, to receive the point of the screw of the front puppet D; these holes are at equal distances from each other, so that by introducing the screw into one or other of them, the bar F can be inclined to the axis of the mandrel, and by releasing the screws which unite *a* and *b*, a finer adjustment can be made of the intermediate spaces between the holes, so as to incline the bar F in any angle within the limits of the length of the cross *a b*.

Williams' Machine for boring brass Cocks.

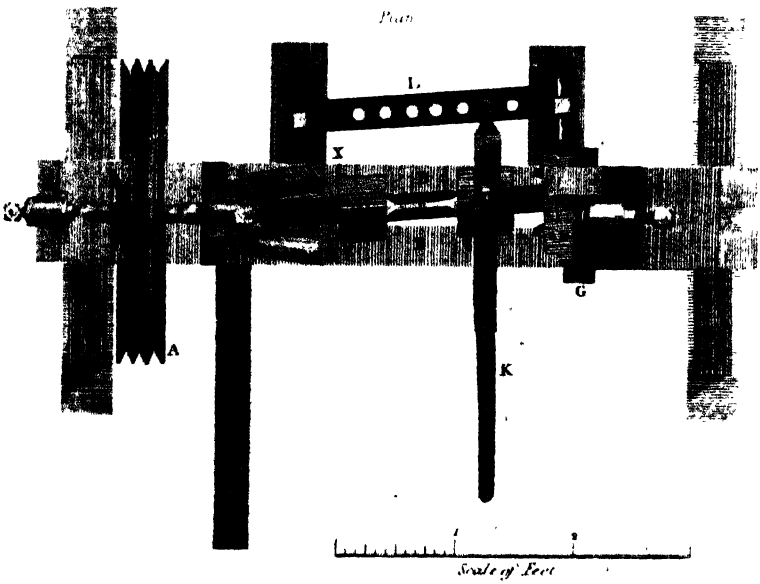
Fig. 1.



Elevation.

Fig. 2

Plan



Scale of Feet

The bar F is supported by an iron frame G, screwed to the front-puppet, and it is kept from rising by an iron clamp *d*, attached to G, and extending over *a b*; the clamp serves, at the same time, as an index to divisions upon *a*, which determines the angle of F and C.

Upon the bar F, two cylindrical sliders, H and I, are fitted to slide as freely and accurately as possible; the former is provided with a steel cutter or tooth X, projecting a small quantity from its circumference, and it is this which performs the cutting or boring within the cone E, fixed to the end of the mandrel.

The cutter slider H, is connected with the slider I, by two iron rods, *e e*, and I is moved along the bar by a lever K, through which is a large opening or eye, to admit the slider I, and it takes its bearing against two pins *f f*, fixed in the slider, and passing through holes in the lever; the lever is supported by an iron-plate L, fig. 2, having several holes to receive a short pin projecting upwards from the end of the lever.

The plate L is supported by two legs, *g g*, fig. 1, which are bolted to wooden blocks projecting from the far side of the cheeks B; one of these bolts (see fig. 2) is passed through an oblong hole in the leg, so that the plate L can be moved backwards and forwards to be always parallel to the bar F.

The manner of using this machine scarcely needs any explanation; the work being put together as above described, and with a cutter X adapted to the size of the cone to be bored, the workman hooks the pin at the end of the lever K into any of the holes in the plate L, and by this means gains a power to thrust the cutter forwards into the cone, by pressing the end of the lever towards the mandrel, which is at the same time revolving with the work to be bored or turned out to a true cone by the cutter X; and it is evident that any number of cones which are afterwards to be turned by the same means, will be precisely of the same size and angle.

Machine for separating Iron Filings from their Mixture with other Metals.

The separation of iron-filings and turnings from those of other metals, has been usually accomplished by the use of a common magnet held in the hand. By this means, the process is very tedious, but by the present invention, many magnets may be employed at once, combined and attached to a machine upon a large scale. The magnetic hammers are so contrived as to take up the iron-filings from the mixture of them with other filings, or metallic particles, placed in the trays or end-boxes, and drop them into the receiving-box in the centre, which is effected by the alternate motion of a winch-handle, working the two magnetic hammers, placed at two angles of a quadrant or anchor. In proportion to the power of the magnets, and to the force of the blow given by the hammers, is the quantity of iron separated from the brass, &c. by the alternate motion, and dropped into the receiver placed in the centre of the machine.

The machine is represented by fig. 4, plate XIX. A is an axis of brass, and B a handle upon the end of it. C is a piece of brass in the form of an anchor, at each end of which a horse-shoe magnet is fixed : *c* is the arch of the anchor, and *d* a piece of brass having a hole through it to receive the legs, *e e*, of the magnet, which is fixed to the arch by a screw *f*, tapped into the arch.

The anchor is mounted upon the axis A, and set in a frame E, which encloses it ; on the outside of the frame, two blocks of wood FF, are situated, in each of which a hollow or tray is formed to receive the filings which are to be separated from the iron they contain.

The magnets fixed at the ends of the anchor, strike upon the filings, and select, by the magnetic attraction, the iron among them ; the anchor is then turned over by the handle B, and the opposite magnet strikes in the other hollow F ; at this time the other magnet is just over the axis, and by the jerk of its opposite magnet striking the block F, the iron-filings are shaken off, and fall down into the bottom of the frame or receiver. In this manner the handle B, being moved backwards and forwards, strikes the magnets alternately in the two blocks FF ;—at the same time that one strikes, the other is cleared by the shock from the iron it has picked up.

G is a screen of thin board to prevent the filings from being scattered.

Description of an improved Pump, for raising Water whilst Wells are sinking or making.

To render the utility of this invention more easily apprehended, it will be necessary to state the inconveniences attending the common mode of operation, and which are intended to be obviated:

First, as it is necessary for the pumps whilst sinking, to be always working upon air, that the water may be kept very low in the pit, the engine of course frequently goes too fast, and carries up, by the violence of the current, small pieces of stone, coal, or other substances, and lodges them above the bucket, which must considerably retard the working of the pump, and wear the leather.

Secondly.—When the engine is set to work, (after having been stopped whilst working upon air, and consequently a quantity of air remaining in the suction-pipe, with the small stones, &c. deposited on the valves of the bucket,) it often happens that the compressure of the air by the descent of the bucket, is not sufficient to overcome the weight of the bucket-valves so loaded with rubbish, and the column of water in the pipes, on which account the pump is prevented from catching its water; the usual remedy in this case, is, to draw the bucket out of the working-barrel, until a quantity of water has escaped by its sides, and displaced the air. It is to be observed, that this often happens from the unnecessary magnitude of the space between the bucket and clack.

Thirdly.—As the pumps are suspended in the pit by capstan ropes, for the purpose of being readily lowered as the pit is sunk; the stretching of the ropes (especially when sinking in soft strata) occasions much trouble, by suffering the pumps to choke; but the most serious evil is, that the sinkers, in shifting the pumps from one place to another, throw them very far out of the perpendicular, thereby causing immense friction and wearing in all the parts; besides endangering the whole apparatus, by breaking the bolts and stays, and straining the joints.

Fourthly.—As the pumps sink, the delivering pipe at the top is raised, by putting on short pipes, generally about a yard at a time, which occasions many stoppages and much hinderance in the work.

Brunton's method of adapting pumps to wells that are sinking.

The Inventor having an engine-pit to sink at Codnor Park Colliery, Derbyshire, belonging to the Butterley Iron Company, he endeavoured to obviate the difficulties stated; and, first, for the purpose of preventing the pumps working too much upon air, he constructed a working barrel, (which in this case was nine inches diameter,) with a side pipe three inches diameter, connected therewith by an opening at the top and bottom; also at the upper end of the side pipe was fixed a valve, so as to slide over and shut the communication with the working barrel; the stem of the valve by which it is regulated, passing through a stuffing-box, and by letting a quantity of water return through the side pipe, to the bottom of the working barrel, (the men at the bottom regulating the valve, so that the pump takes the water as it comes,) very little rubbish is then taken into the pump, and much wear and tear of buckets prevented.

Secondly.—By the use of this valve and side pipe, the necessity of ever drawing the bucket to displace the air was precluded. The clack piece was made as small as possible, and the clack with its gearing very low, in order to have as little space as possible between the bucket and the clack. The clack, as represented in the plate, possesses the advantage of being easily caught by the clack hook, in case of being under water. The ring prevents it from oversettling, and thereby fastening itself in the pumps, and the vales are very easily repaired by unscrewing the cross-bar, which admits of their being taken off and replaced.

Thirdly.—The Inventor avoids the inconvenience of suspending the pumps by ropes, by forming the suction-pipe in two pieces, an inner and outer pipe; the outer pipe is bored for about six inches in length, and the inner one turned cylindrically to fit it; they slide, like the tubes of a telescope, into each other, the whole length of a regular pipe, viz. nine feet; and they are made tight by collars of leather, surrounded by a cup filled with water and clay. The pumps are supported at proper distances, so as to suit the length of the pipes, by beams, and across those are other beams upon which the flanches of the pipes rest; these last are not fastened by any bolt, in order that they may be readily removed. The pumps by these means remain stationary, and the suction-pipe lengthens as the pit is sunk, until it is drawn out to its full extent. The whole column is then lowered to the next flanches, and another pipe is added to the top; the lower end of the suction-pipe is formed somewhat like a crank, in order

that the sinkers, by turning it round upon the other pipe, may move it from one place to another, and so prevent the necessity of sinking immediately under it.

Fourthly.—The pump being stationary as above stated, the pipe at the top will of course deliver the water at the same level at all times, and instead of being obliged to lengthen the column every yard sunk, it will only be necessary every nine feet.

By sinking the pit above-mentioned in the manner stated, the whole of the difficulties so generally complained of were obviated, the safety of the workmen employed greatly increased, and much time, labour, and expense saved.

For more explicit information, relative to this invention, the following references to plate XXI. will be useful.

Fig. 1, is a section of a shaft or pit, with the pump fixed in it; it is cast in lengths of nine feet each, screwed together by flanches, and supported by beams extending across the pit, (as shown in the plan, fig. 6,) short pieces are laid across these, with semi-circular holes in them; these being put round the pump, just beneath a flanch, sustain the pump firmly, but may quickly be removed when it is required to lower the pumps in the pit; and, as they are not fastened, they do not prevent the pump from being drawn upwards.

A, fig. 1, is the door which unscrews, to get at the lower valve or clack of the pump; this is more clearly explained in the enlarged section, fig. 2, where A has the same designation.

B, fig. 2, is the working barrel, with the bucket D, working in it.

E is the clack, also shown enlarged in figs. 3 and 4.

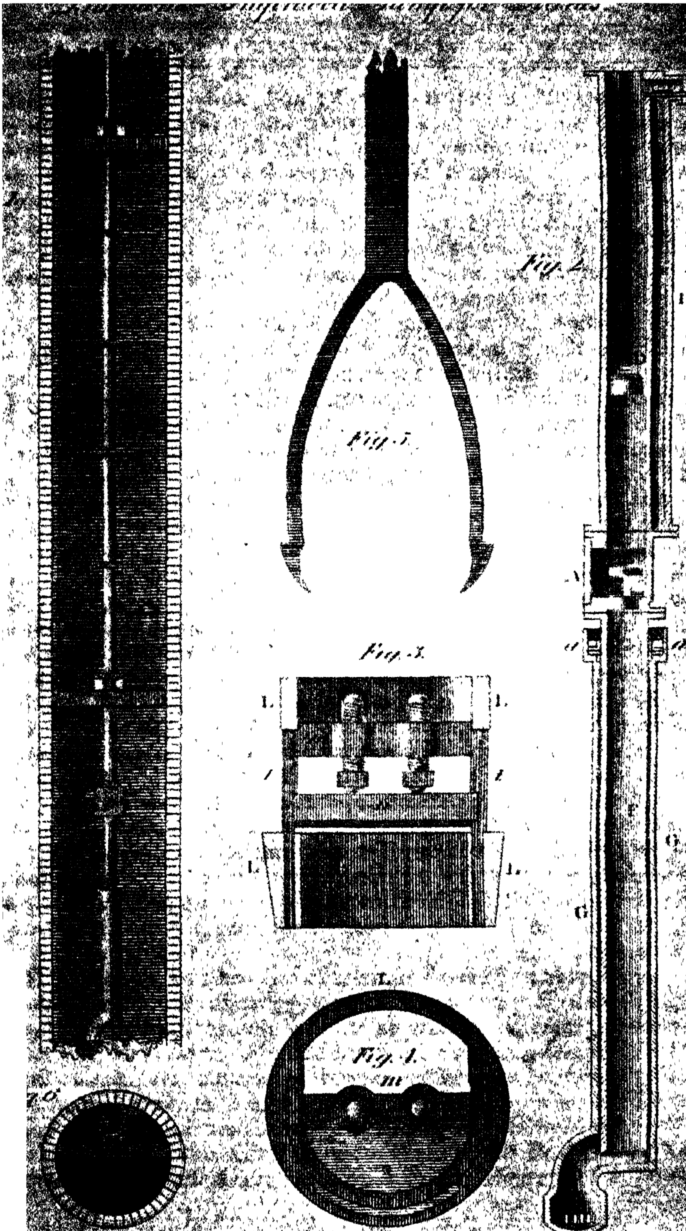
F is the suction-pipe.

GG, the moveable lengthening piece; this slides over and includes the other, as in fig. 2, when the pump is first fixed; but, as the pit is sunk, it slides down over the pipe F, to reach the bottom, as in fig. 1; the outside of the inner pipe F, is turned true and smooth, and the inside of the outer pipe G, at the upper end, is bored out to fit it; the junction is made perfect by leathers placed in the bottom of the cup, *a a*, which holds water and wet clay over them, to keep them wet and pliable, and consequently air-tight; the lower extremity of the suction-pipe G, terminates in a nose, pierced with a number of small holes, that it may not take up the dirt; this nose is not placed in a line with the pipe, but curved to one side of it, so as to describe a circle when turned round; by this means the sinkers can always place the nose in the deepest

part of the pit, as shown in fig. 1; and when they dig or blast a deeper part, they turn the nose about into it, the sliding tube lengthening down to reach the bottom of it; by this means there is never a necessity to set a shot for blasting so near the pump-foot, as to put it in any danger of being injured by the explosion, as is the case in the common pump; in which this danger can only be avoided by moving the pump-foot to one side of the pit, which necessarily throws the whole column of pumps out of the perpendicular.

The construction of the clack is explained by figs. 3 and 4, the former being a section, and the latter a plan; LL is a cast-iron ring, fitting into a conical seat in the bottom of the chamber of the pump, as shown in fig. 2; it has two stems, *l l*, rising from it, to support a second iron ring MM; just beneath this, a bar *m* extends across from one stem to another, and has two screws tapped through it; these press down a second cross-bar *n*, which presses the leather of the valves down upon the cross-bar of the ring L, and this holds it fast, forming the hinge on which the double valves open, without the necessity of making any holes through the leather as in common; but the chief advantage is, that by this means the clack can be repaired, and a new leather adapted, in far less time than at present, which is an object of the greatest importance; for, in many situations, the water gathers so fast in the pit, that if the clack fails and cannot be quickly repaired the water rises above the clack door, so as to prevent any access to it, and there is no remedy in the common pump, but drawing up the whole pile of pumps, which is a most tedious and expensive operation. In this pump, the clack can at any time be drawn out of the pump, by first drawing out the bucket, and letting down an iron prong, fig. 5, which has hooks on the outsides of its two points; this when dropped down will fall into the ring M, and its prongs springing out, will catch the underside, and hold it fast enough to draw it up.

Another improvement consists in the addition of a pipe II, fig. 2, which is cast at the same time with the barrel, and communicates with it both at the top and at the bottom, just above the clack; at the upper end the pipe is covered by a flat sliding plate, which can be moved by a small rod, *b*, passing through a collar of leathers; the rod has a communication by a lever, so that the valve can be opened or shut by the men in the bottom of the pit; the object of this side pipe is, to let down such a proportion of the water which the pump draws


Fig. 2.
Fig. 5.
Fig. 3.
Fig. 1.
H
A
a
G
L
l
m

as will prevent the pump drawing air; though of course the motion of the engine will be so adapted, as not to require a great proportion of the water to be thus returned through the side pipe; yet it will not be possible to work the engine so correctly, as not to draw some air without this contrivance; and if it does, it draws up much dirt and pieces of stone into the pump, besides causing the engine to work very irregularly, in consequence of partially losing its load every time the air enters the pump. Another use of the side pipe is, to let down water into the chamber of the clack to fill it, when the engine is first set to work, after the pumps have been standing still, and the lower part of the barrel and chamber is empty.

The trials which have been made of this pump, have fully demonstrated that the invention is of great importance to those interested in the pursuits to which it is applicable.

Description of an improved Loom, by which Purses, Pockets, Sacks, &c. may be woven without requiring a Side-seam, and Work in general may be better executed.

In this loom, represented by fig. 1, plate XXII, an oblong frame, A, is laid down horizontally, and secured at the four corners with triangular braces, to keep the frame properly square. Three of these braces, BBB, are visible.

Four posts, CCCC, are fixed upright in mortise holes on the above frame. The front posts are supported, both behind and before, with diagonal timbers, DDDD, to keep the breast-roll E, from giving way in the least by the heavy stroke of the batten FF, on the quarter or work. The two hinder posts, GG, are held firm by two diagonal supports, HH, within the loom, to bear against the counter-weights II, and the great weight V, hanging on the work K, and the force of the batten F.

A loom constructed upon this plan, without shorings or supports, will make both strong and slight works firm and good, and its advantages are therefore more important than might be supposed. As journeymen weavers generally live in low-rented houses, the floors and party-walls of the rooms where

they weave, are mostly bad and weak; so that the common looms cannot be firmly placed, and the man finds great difficulty in getting his loom into tolerable order; yet if the loom is not set square, and prevented from giving way while used, no work can be made strong and good. The silk chafes and cuts, and the workman is harassed for want of knowing the real cause of the mischief, or not having skill to correct it. These inconveniences are obviated by the bottom-frame braced as above mentioned; any ordinary workman can set up this loom well, though it requires a person of considerable judgment to set up an ordinary one. It is a common fault, where shorings or supports are used, to make them too long and slender, in which case, even when they rest against good walls, there is a trembling motion, and if the shake only amount to the hundredth part of an inch, it will take out that stiffness which ought to be in the work. In consequence of the defects thus occasioned in the manufacture, the poor weaver is often turned out of employment, and the master suffers in his property, as he cannot sell the fabric at the price it ought to be worth.

A variety of other disadvantages, well known to the trade, attend the use of the loom, not properly squared, shored, and fixed; but it may suffice to refer to one, which is material. A loom set up with stays, must remain always at the same place, although the light may frequently not be suitable to the work, and even when the moving of the machine a few inches would render the light proper. In this point of view, the improved loom is particularly convenient.

METHOD OF WEAVING SACKS, &c. IN THE LOOM ABOVE DESCRIBED.

L, the seat of the loom.

M, the treadles, six in number, to raise the harness.

N, the counter-meshes to raise the tumblers O, moveable on a pin a little beyond their centre, and which act on the harness P, by raising such parts thereof as they are attached to at their extremities.

Q, the work in the loom.

R, the reed which strikes the shoot or weft close up.

S, the back beam on which the warp or thread is wound.

TT, the rods to preserve the crossing of the threads.

V, the main weight suspended by a lever U, from a bar

W near its centre; the other end of the lever is fastened by a cord to the bottom frame of the loom at X.

Y, the rack on the working beam.

Z, the catch, to hold the teeth of the rack.

To weave a sack, press down the second treadle on the right hand side, and throw one shoot with the shuttle; next press down the second treadle on the left-hand side, and throw another shoot; then proceed in the same manner with the third on the right, and the third on the left, till a sufficient quantity is made; then work the two outside treadles and two shoots.

In weaving sacks, it is necessary, between the finishing of one sack and the commencement of another, to pass a thin slip of wood through the threads, in order to form a space between the two sacks.

Improved Method of warping and preparing Webs for Weavers.

The general object of this invention is to lay the yarn or threads evenly upon the warping mill; and when the warp is transferred from thence to the yarn-beam of the loom, to place the threads regularly upon the beam, the whole breadth that the cloth is intended to be when made, so that there may be a proper and equal tension of the threads, betwixt the cloth and the yarn-beam. In striped patterns, also, the figure is thus more distinct, and better managed than in the common way.

Fig. 2, pl. XXII, exhibits the upper and lower parts of the warping-mill, detached from each other, in order to show them of a better size.

A, is the top spindle of the mill, running in a collar within the upper cross-piece B.

C, the lower spindle or pivot, upon which the mill turns round in a pivot-hole, in the lower cross-piece D.

E, a cord wound round the spindle A, from which it passes over a pulley F, then under the pulley G, and over the pulleys HH, to the pulley I, attached to the box K; thence ascending to the pulley L, it terminates at the catch M. The intention of this cord is to give a regular motion to the solid box K, so that the box may slide easily up and down the

whole length of the upright piece N, and distribute the threads O, evenly upon the mill, as they are drawn from the bobbins. These threads pass, a few together, between each of the small running rollers P, under an iron rod Q, which confines them from rising. After passing the rollers, all the threads approach each other, and are wound round the mill as it turns upon its pivot.

RRR, three pegs, fixed at the lower part of the mill, upon a horizontal piece of wood, lying between two of the upright staves of the mill. The use of these pegs is to keep small portions of the threads apart, so as to be placed more easily afterwards in the conducting frame. The manner in which these threads are crossed, and returned upon the mill, is shown at RRR, the pegs being engraved of a larger size than the other parts, to explain their use more clearly.

S, a rachet-wheel and catch upon the box K, which regulates the distance at which the threads should be laid upon the mill.

M, another ratchet-wheel and catch, fixed on the upper cross-piece or arm B, to tighten the cord which moves the box.

Fig. 3, Y shows the lower part of the conducting frame, or separater, which has some resemblance to a very coarse comb, with the teeth uppermost. When the warp is removed from the mill to the loom, the small portions of the threads separated by the pegs RRR, are placed within each of these teeth: the cap, N, or upper part of the instrument, is then put over the teeth, to prevent the threads coming out of it; the whole warp is then drawn through it gradually, as it is wound upon the yarn-beam, and laid very level thereon, the breadth that the cloth is intended to be made; rather contracting the breadth, by placing the conductor obliquely, as a greater quantity is wound upon the beam.

By the use of this machine in warping, it has been found that weaving may be done five per cent. cheaper than in the common way: the cloth also will be firmer, and the necessity of cutting the warps at the ends, as has been usually done, is precluded.

A Loom for weaving Fishing Nets.

A machine for weaving fishing-nets has long been a desideratum. Fishermen frequently having their nets broken by dog-fish, and other marine animals, and they experience many difficulties after such accidents, on account of the length of time required by the present mode of netting, in repairing their injured nets, or in making others. A fisherman is sometimes compelled, from these obstructions, to relinquish fishing for a whole season. Any method, therefore, which leads to accelerate the fabrication of nets, without increasing the expense of them, must be beneficial to the community. These considerations swayed the Inventor of the loom described below, in devoting much of his attention to this branch of manufacture, until he succeeded in uniting economy and expedition.

The loom is represented by plate XXIII, figs. 1 to 9.

Fig. 1, is the machine in a state ready to begin working, supported in a wooden frame. A is a beam on which the twines for the net are rolled, in number equal to the knots tied, and from which they pass through circular tubes fixed in a bar B, (shown by dotted lines through the pulley, but seen better in fig. 2,) which is fixed near the circumference of two equal pulleys, CC, that turn on their axes by means of a cross treadle, with small pulleys at each end, DD, through which passes a band, one end of which is fastened on the frame at E, and the other on the pulley C. At F, the band through the other pulley has one end fastened on the frame at G, and being wound round the farthest pulley C, is fastened on the under side of it, which by the alternate action of the treadle on its axis H, moves the pulleys CC, and circular tubes, from their situation in fig. 1 to that in fig. 3, and back again.

In the centre of the pulleys CC, is fixed another bar P with a dove-tail groove, where the pirns that contain the twine are supported, (it being necessary to have two threads for every mesh, also one pirn more than there are tubes.) In a groove under the dove-tail is a slider L, moved by a wire K, fixed in each end of it, having pins in it, by which it moves the pirns backwards or forwards over the notches in the bar I, so as to cast a part of the knot: the pulleys CC, and bar B, move round the bar I as an axis, but independent of it; the bar I being fastened through the pulleys to the frame,

M is a moveable bar (centred within two supporters, NN, having two joints) with hooks, both for catching the twine at the end of the circular tubes, and by crossing the hooks to the other side of the points of the tubes, to give the twine a turn for forming the knot; and by raising the points of the hooks, the ends of the tubes enter between them, as shown in fig. 4, and by the circular motion of the bar B, when the two pulleys CC are turning on its centre by the foot, on the end, No. 1, of the cross treadle; and until the knots so formed are close to the bar B, fig. 3, (it is then what is called a running knot,) a part of which falls into a notch cut below the level of the supporters of the pirns in the bar I, the pirns must then be slidden over the notches that contain the twine, the knot is then cast, and then by the foot on the other end, No. 2, of the cross treadle, the points of the tubes are returned to their former position; remove the knot by disengaging the hooks and the tubes, the knots are then made tight as the wrought part of the net is rolled on the beam O, on one end of which there is a pulley, P, with a band that communicates with the pulley on the end of a short roller Q, in which are fixed four cross bits of wood, that answer the purpose of treadles for the feet, by which it is drawn tight.

R is another short roller, communicating with the roller A, serving to give out the proper quantity of twine for the length of the meshes, or to hold it while the other roller tightens the knot. S is the seat.

Fig. 2, is a plan of the machine; the moveable bar and treadles are left out to prevent confusion.

Fig. 3, is the situation of the running knot when the pirn goes through it.

Fig 5, is the tube in the same position, showing the manner in which the knot is twisted round it; and having the pirn and slider L taken out of the bar I, the dotted lines showing at what height they come together. In the slider L there are two pins, TT, to prevent its rising high enough to touch the string; and in the bar I there are two wires OO, like staples, to support the slider L in its place.

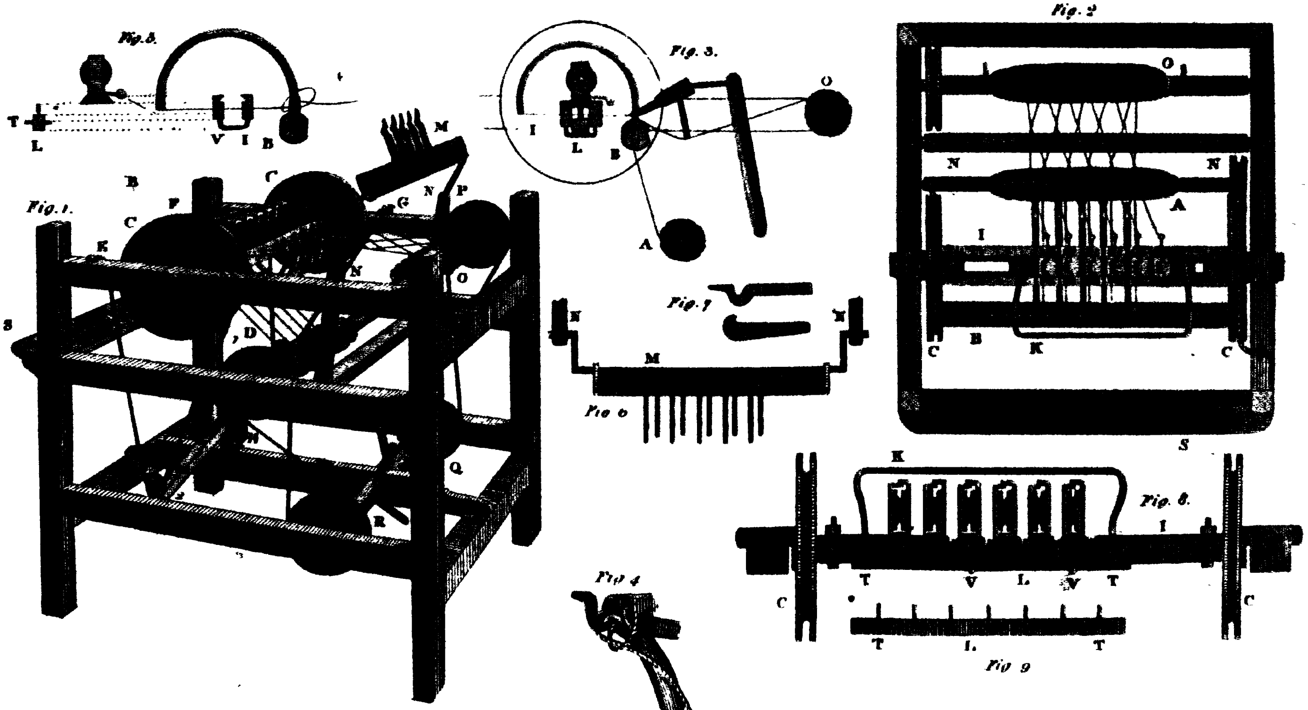
Fig. 6, is the moveable bar M with the hooks.

Fig. 7, shows the hooks at large.

Fig. 8., is the bar I, showing the notches in which the strings lie to let the pirns pass over them, (when the tubes are brought over as in fig. 3.)

Fig. 9, is the slider L, with the pins that move the pirns.

Robertson's Loom for making Fishing Nets. MECHANIC. PL. XXIII.



It appears by a statement of the Inventor, that the nets used in the northern fisheries are of one breadth throughout. He estimates that he can make three courses of one hundred meshes each, in one minute; that such a loom should be about 3½ feet wide, and would cost about fifteen or sixteen pounds.

Method of preserving Cordage.

For this invention a patent was taken out, the specification of which is dated June 5, 1801. It applies to an object of great national importance, and the specification is one of the most perspicuous on record. It would be equally honourable to Patentees, and advantageous to the nation, if the like fulness of explanation were always afforded.

The principal substance of those which the Patentee has invented the application of to cordage, is any resinous matter whatever, deprived of its mucilage and superabundant acid, either wholly or in part, and as the cheapest of all resinous matter is tar, he explains the application of them by having reference to it. Tar, whether in its original or in its more inspissated state, in which it is applied to cordage, (by the white yarns being passed through it, and the superfluous quantity expressed,) contains a considerable portion of mucilage, which causes the tar, with which the ropes are impregnated, to be dissolved in that fluid against which it is intended to preserve them. Tar also contains a considerable portion of acid, easily separable from it, which redundant acid injures the strength of the yarn. Both these inconveniences may be very much, if not wholly done away, by the use of tar or pitch deprived of their mucilage and superabundant acid, which may either be done purposely by the rope manufacturer, by methods easily practicable, or its component parts may be purchased of the distillers of tar; *viz.* in essential oil of tar, and in pitch, a due combination of which will form a substance similar to the tar used in the manufacture of ropes as to inspissation, or approach to the state of pitch. This substance may, when the yarns are passed through it, either be cold, or in a moderately warm state, or of any degree of heat. Heat is, however, to be avoided, both as unnecessarily wasting a quantity of essential oil, and inducing such degree

of injury to the yarn as arises from its exposure to great heat. If the described resinous matter be used either cold or of a moderate heat, it will be advisable to deprive the yarn of moisture, and give it a degree of heat, previously to its entering into the resinous substance designed to impregnate and coat it, viz. by laying the yarn upon the floor of a kiln, or by any means to produce the desired effect. The essential oil of tar, which may be used to the greatest advantage in mixing with the pitch, is that of the first distillation, sometimes called brown spirit, or brown oil, of which about five or six gallons will be required to the hundred weight of pitch. Also the residuum of the second or subsequent distillation will answer, combined with a small quantity of depurated pitch. The cause of this pitch, made by the distillers, being in a great degree depurated from the mucilage, and from the superabundant acid of tar, is, that in its distillation it is mixed with water, which in the act of ebullition separates much of the mucilage and acid from the pure resinous matter; and during its distillation, the essential oil and an acid spirit are thrown off together. The Patentee then adverts to various measures which may be used by the rope manufacturer, *viz.*

He may pursue the processes of the tar distillers, and the methods before described; or he may wash the tar by agitation of it for a due continuance, in cold, warm, or hot water; or he may boil it with water, which in the action of ebullition will agitate and wash the tar, and after it has parted with a sufficient portion of its essential oil, he may separate it from the water, and afterwards pass his yarns through it, in such a degree of temperature as he may see expedient; or he may combine any of the methods herein mentioned; and, if he chuse to save that portion of essential oil which is necessarily thrown off in inspissating the tar, he has only to clap upon his kettle the head of a still, with its apparatus.

The greater proportion of water the tar is boiled with, and the greater number of times the water is drawn off from it and renewed, the more perfectly it will be cleansed of its mucilage and acid. Two or three times the quantity of water, as of the tar will answer very well. After it has boiled for some time, which ought not to exceed, but rather be short of, the period in which the tar will become of sufficient inspissation for use, (which will depend on the quickness of the boiling, and must be regulated by the opinion of the manufacturer,) the fire may then be slackened or put out, and the water and tar may be suffered to separate in the kettle, or they may be

drawn off into a vessel for that purpose. The tar will quickly subside, and leave about it a yellowish brown water, of an acid empyreumatic taste, charged with mucilage, and having an oily scum on its surface. The vessel into which the tar and water are drawn, ought to be of a conical shape, with its narrow end downwards, at the bottom of which should be a cock, and another about a foot higher. Through the lowest of the cocks the tar should be drawn off whilst yet warm; and through the other (or by any cock above it) the acidulous mucilaginous water may be let off. The tar thus purified should, after pouring off any water which may have risen to its surface, be put into the tarring kettle, and after boiling a little time it will throw off any water which may remain mixed with it; it is for this cause that the Patentee has recommended the previous washing and boiling, to stop short of the period of due inspissation of the tar. If the process chance to have been continued too long, the due addition of essential oil of tar will effect a remedy. The above operation of once boiling will improve the tar greatly, and extract most of the acid; but if the mucilaginous acid water be drawn off, and a fresh quantity of water be added, and a second boiling take place, the resinous matter will become more pure, and, although quickly separating from the water, it may part of it float in one or more masses, and in this case will require more attention in drawing it off from the separating vessel, or further delay until the whole of the tar has subsided.

Tarred cordage, when old, or kept in a hot climate, becomes rigid, from the flying off of the essential oil of the tar, which will still more rapidly take place when used in the depurated state above-mentioned. To remedy this inconvenience in cordage, and consequently make it more durable as well as more pliable and useful, the expressed oils of vegetables, or animal oils, or fats, may be added to the more or less inspissated tar, whether it be or be not deprived of its mucilage and to render their application more perfect, the oils may be cleansed of their mucilage by processes similar to those described for cleansing the tar. Whale oil, rape oil, and linseed oil, are, from their cheapness and abundance, the most eligible of the oils. A small proportion of them, at the will of the manufacturer, may be used, according to the ductility wanted, or to the heat of the climate. Suppose the quantity wanted for the particular purpose to be one-fortieth, the tar ought then to be a little more inspissated than if the oil were not used. The oil, (of which the Patentee prefers

that of animals) may be mixed and incorporated with it during any time of its boiling or simmering. This lubricating compound of resinous matter and oils is particularly useful in the manufacture of twice-laid cordage; which, from the rigidity of the yarns, can seldom be so far compacted in the strands as to keep out water, and therefore soon decays. By the proper use of the aforesaid compound, twice-laid tarred cordage will in all cases be very much improved; and if proper care be taken in the selection of the yarns, will be nearly as good as new rope. The methods which the Patentee deems most eligible are, either to apply to the yarns a thin solution of depurated tar and oil, laid on with a brush after the usual manner or in any other way, or to pass the yarns drawn from old cordage through a second process of tarring, and expressing the superfluous quantity by nippers; attending also to the peculiarity of the circumstance of the yarns about to be used, which, having lost much of the essential oil of the tar formerly applied, will so far require a thinner solution of the substance afore-mentioned, than is eligible to be used in the first process. The residuum of the second distillation of the tar oil of distillers, or brown oil of tar, may more or less in quantity be added to the afore-described purified tar, according to its degree of inspissation; and if the yarns be drawn from cordage tarred in the common way, it will be adviseable to use a larger proportion of animal or vegetable oils, than for new cordage. If in place of inspissating the tar, for any of the uses before-mentioned, recourse be had to the pitch and essential oil of the tar distillers, the essential oil ought not to be mixed with the pitch, or pitch and oil, until the latter be melted and brought to such a degree of coolness as is consistent with its proper fluidity, at which time the essential oil may be progressively added and stirred up with it, without which precaution much of the essential oil will be wasted. The animal or vegetable oils may then be added, if not done before. As to the consistency either of the pitch and essential oil, or of their mixture with animal or vegetable oils, it must be judged of and determined by the opinion of the manufacturer, which he may readily form by taking a small quantity out of the kettle, and letting it cool. The using of animal fat, suet, or tallow, as a constituent part of the substance for preserving cordage, is similar in its process to that before-described; the quantity of it must depend on the degree of inspissation of the tar. The Patentee is of opinion that it may be advantageously used to one-tenth of the whole,

and considerably higher, were it not for the comparative dearness of it, from which cause it may be eligible to reduce its quantity to a thirtieth or fortieth part.—One advantage, no further noticed than by implication, attendant on the method of using oily or greasy substances, is, that the ropes will be limber and pliable in all climates, which every seaman knows is of the utmost consequence in the working of a ship, as well as in addition to the durability of the rope. For cold climates, the Patentee recommends whale oil, and for hot climates suet or tallow, which should not be rancid, as there is then a disengaged acid; for which cause fresh suet is in general preferable to tallow.

For the preservation of the bolt-ropes of sails, or of any other cordage in which it may be deemed expedient to incur the charge, the Patentee makes use of drying oils, brought to any degree of inspissation, or of heat, according to the opinion of the manufacturer, (who must be careful to stop short of that degree of heat in which they will inflame.) The ropes, or their separate strands, may be passed through any of these oils, or the yarns themselves may be passed through, and the superfluous oil be expressed by nippers, as in the process of tarring. Resinous matter, essential oil, or any other ingredient may be used with the drying oil, according to the views of the manufacturer.

The invention also goes to the carrying forward the before-recited improvement of the rope, immediately previous to, or during the putting of its strands together. In the usual method, the top (an instrument which separates the strands until the instant of their combining into a rope,) is made to slide uniformly, and without jerks, by previously rubbing a piece of tallow along each of the strands: now in place of tallow, the Patentee makes use of any of the following compositions; *viz.* tallow mixed with a due quantity of resin or of depurated pitch, the former of which is only preferable on account of its brighter colour; and as the process is the same in both, in explaining it he speaks of the former.

The two ingredients of resin and tallow should be melted together, and run into a cask; from which, if the resin be not superabundant, the substance thus formed may be cut out like tallow, and applied in a similar manner, by a piece being rubbed along the strands. A mixture of two parts tallow and one of resin is nearly as slippery as tallow, and in warm weather particularly a larger proportion of resin may be used, which will make the coating of the rope more dura-

ble; in place of either pitch or resin, the partly inspissated tar, either purified or not, but the former is preferable, may be used mixed with tallow; also, the inspissated tar or resin, or pitch mixed with animal or expressed oils, laid on the strands with the hollow of the hand or with a brush, will answer the end. And both as to duration and colour, with an attention likewise to cheapness, a useful compound may be made by the addition of a sufficient quantity of brown oil of tar to a due proportion of resin and boiled linseed oil or any other drying oil, prepared with litharge or otherwise. The following proportion will answer the end; *viz.* resin four parts, boiled linseed oil four parts, and brown oil of tar three parts: the result will be, that they will coat the rope with what will shortly become a dry and moderately elastic varnish.

With this coating, and all of them except that containing tallow, it will be advisable to let the ropes lie on the stake-head-posts until a due desiccation take place.

The Patentee does not confine himself to any of the before-mentioned proportions, as they may be varied according to the opinion of the manufacturer, to the climate, and the use the rope is designed for, and to the degree of economy which may be expedient. Resinous substances, depurated or otherwise, may be mixed with any others capable of answering the purpose described; but as those mentioned are comparatively both cheap and abundant, it appears unnecessary to enlarge farther.

To render the value of the preceding invention obvious to those who may not be fully apprised of it, we insert the following report by William Allen, lecturer on chemistry at Guy's Hospital London, and highly distinguished for the accuracy of his experiments.

"Common tar unprepared contains a quantity of vegetable acid, and apprehending that this acid might injure the texture of cordage, the following experiment was made: A piece of twine, which by previous trial was found capable of supporting 61 pounds without breaking, was immersed in vegetable acid, and after 46 hours it was so much injured that it broke with a weight of less than 16 pounds. A piece of the same twine was immersed for 46 hours in the essential oil, which came over in distillation from the tar, and although it had suffered no diminution of strength at the termination of its immersion, yet after being exposed three days to the air, it was only capable of bearing 31 pounds.

"The Stockholm tar used in these experiments was found to contain about 7 *per cent.* of vegetable mucilage, capable of being converted into an acid in a hot climate, when the cordage is immersed in water. The tar also contained as much real acid as there is in *an equal measure of common vinegar;* but by repeatedly boiling the tar in water, according to the method prescribed, it is freed from its acid and mucilage, and may be employed in the manufacture of cordage with great advantage in the place of common tar. Also, if the prepared tar be boiled down so much further, as to deprive it of that portion of its essential oil, which it is found necessary to retain to prevent tarred cordage being too rigid, and the place of the essential oil be supplied with a due portion of fixed or expressed oil, it is probable that those injuries will be done away, which arise from the action of essential oil on the fibres of the hemp, and from the rigidity of cordage, experienced in vessels returning to cold from hot climates, where the essential oil is considerably thrown off.

(Signed) WILLIAM ALLEN.

"*Plough Court, Lombard-street, London,*
28th of 7th Mo. 1802."

Improved Steel-Yard.

The place of inspector of weights and measures, occupied at Geneva, by C. Paul, having given him an opportunity of carefully examining a great number of steel-yards, he found reason to be convinced that the greater part of these instruments are constructed on bad principles, and seem to have been made by artists unacquainted with the properties of the lever. He has succeeded in his attempt to improve them.

Steel-yards, in the common purposes of commerce, have two advantages over balances: 1. That their axis of suspension is not loaded with any other weight than that of the merchandise, the constant weight of the apparatus itself excepted; while the axis of the balance, besides the weight of the instrument, sustains a weight double to that of the merchandise,

2. The use of the balance requires a considerable assortment of weights, which causes a proportional increase in the price of the apparatus, independently of the chances of error which it multiplies, and of the time employed in producing an equilibrium. These motives induced C. Paul to employ his thoughts on the means of so far improving steel-yards, that, either in delicate operations of the arts, or in those of the same kind which are often so necessary in the practice of the physical sciences, these instruments might be substituted with advantage for common balances. In order the better to explain in what the proposed improvements of the steel-yards consist, it will be proper to point out what were the faults of the common ones.

1. There were none of them, in which the points of suspension were exactly in the prolongation of the line of the divisions of the beam; a circumstance which necessarily changed the relation between the arms of the lever, the power and resistance, according as the direction of the beam was changed from a horizontal position. Steel-yards are not uncommon, in which a degree only of difference in the inclination of the beam produced a difference of more than a pound in the result.

2. When the shell, the beam, and the weight, are made at hazard, a person who possesses a steel-yard cannot know when the instrument is deranged; and even an artist cannot repair it, but by repeated trials, and with a great loss of time.

3. The construction of the common steel-yards, which have a small and a large side, renders it necessary to invert them frequently: a laborious operation when these instruments are heavy, and which exposes the axis to the danger of damage by the effect of the shocks which that turning occasions.

As these double sides render it necessary to have a beam very straight, in order that it may be less faulty, it readily bends, which is a new source of error; and, the face which bears the numbers, being narrow in proportion, it is difficult to form on it figures sufficiently distinct. These inconveniences are all avoided by the construction to be proposed, which presents, besides, several other advantages not possessed by the old steel-yards.

1. The centres of the movement of suspension, or the two constant centres, are placed on the exact line of the divisions of the beam; an elevation almost imperceptible in the axis of

the beam, in order to compensate for the very slight flexion of the bar, alone excepted.

2. The apparatus, by the construction of the beam, is balanced below its centre of motion; so that when no weight is suspended, the beam naturally remains horizontal, and resumes that position when removed from it, as also when the steel-yard is loaded and the weight is at the division, which ought to show how much the merchandise weighs. The horizontal situation in this steel-yard, as well as in the others, is known by means of the tongue, which rises vertically above the axis of suspension.

3. It may be discovered that the steel-yard is deranged, if, when not loaded, the beam does not remain horizontal.

4. The advantage of a great and a small side (which in the others augments the extent of their power of weighing) is supplied by the very simple process of employing different weights on the same division, by which the same end is accomplished, with some additional advantages. The numbers of the divisions on the bar, point out the degree of heaviness expressed by the corresponding weights. For example, when the large weight of the large steel-yard weighs eighteen pounds, each division it passes over on the bar is equivalent to a pound; the small weight, weighing eighteen times less than a large one, will represent on each of these divisions, the eighteenth part of a pound or ounce; and the opposite face of the bar is marked by pounds at each eighteenth division. In this construction, therefore, we have the advantage of being able, by employing both weights at once, to ascertain, for example, almost within an ounce, the weight of 500 pounds of merchandise. It will be sufficient to add what is indicated by the small weight in ounces, to that of the large one in pounds, after an equilibrium has been obtained by the position of the two weights, viz. the large one placed at the next pound below its real weight, and the small one at the division which determines the number of ounces to be added.

5. As the beam is divided only on one side, it may have the form of a thin bar, which renders it much less susceptible of being bent by the action of the weight, and affords room for making the figures more visible on both the faces.

6. In these steel-yards the disposition of the axis is not only such that the beam represents a mathematical lever without weight; but in the principle of its division, the interval between every two divisions is a determined and aliquot

part of the distance between the two fixed points of suspension; and each of the two weights employed has for its absolute weight the unity of the weight it represents, multiplied by the number of the divisions contained in the interval between the two constant centres of motion. Thus, supposing the arms of the steel-yard divided in such a manner that ten divisions are exactly contained in the distance between the two constant centres of motion, a weight to express the pounds on each division of the beam must really weigh ten pounds; that to point out the ounces on the same divisions, must weigh ten ounces, &c. So that the same steel-yard may be adapted to any system of measures whatever, and in particular to the decimal system, by varying the absolute heaviness of the weights, and their relation with each other. The application of this principle will be seen hereafter in the description of the steel-yard, to which the Inventor has given the name of *universal steel-yard.*

But, to trace out, in a few words, the advantages of the new steel-yards for commercial purposes, it may be observed, 1. That the buyer and seller are certain of the correctness of the instrument, if the beam remains horizontal when it is unloaded and in its usual position. 2. That these steel-yards have one suspension less than the old ones, and are so much more simple. 3. That we obtain, with the greatest facility, by employing two weights, the exact weight of merchandise, with all the approximation that can be desired, and even with a greater precision than that given by common balances. There are few balances which, when loaded with 500 pounds at each end, are decidedly sensible of an ounce; and the new steel-yards possess that advantage, and cost one half less than balances of equal force. 4. In the last place we may verify, every moment, the justness of the weights, by the transposition which their ratio to each other will permit; for example, by observing whether, when the weight of one pound is brought back one division, and the weight of one ounce carried forwards eighteen divisions, the equilibrium still remains.

The *universal steel-yard* serves for weighing in the usual manner, and according to any system of weights, all ponderable bodies, to the precision of half a grain in the weight of a hundred ounces; that is, of a ten thousandth part.

It is employed besides, for ascertaining the specific gravity of solids, of liquids, and even of the air itself, by processes extremely simple, and which do not require many subdivisions in the weights. This apparatus is represented, plate XXIV. fig. 1.

The beam AB of this steel-yard is constructed on the same principles as the commercial steel-yard, above alluded to, its dimensions only are smaller. The shears are suspended by a screw to a cross bar of wood supported by two pillars, which rest on the two extremities of a small wooden box furnished with three drawers, and which serves as the stand of the apparatus. This beam is divided into 200 parts, beginning at its centre of motion. The division is differently marked on the two faces: on the anterior face the numbers follow each other from 10 to 200, proceeding towards the extremity; and on the other face, represented apart at F, the numbers are marked in the opposite direction. The utility of this arrangement will shortly be explained.

The small frame G is intended to prevent the oscillation of the beam, and it is placed at the proper height by means of the nut and screw by which it is suspended. Above the beam is seen a small cross bar of brass, suspended by its two extremities from the cross bar of wood. Different weights are hooked to it, each having its particular value marked on it. A small mercurial thermometer, having the two most usual divisions, is suspended to the cross bar, to be in readiness, in delicate experiments, to point out the temperature of the air and the water. The axis of suspension of the steel-yard rests upon two beds of very hard well-polished steel. The case is the same, but in a reversed situation to the axis which supports the hook C, that serves for suspending different parts of the apparatus according to the purpose to which it is to be applied.

When this apparatus is to be employed as a common steel-yard, suspend from it the brass shell E, which is an exact counter-balance for the weight of the beam when unloaded. The beam then assumes of itself a horizontal situation. Then search for the equilibrium of the substance put into this shell, by placing on the beam the weight and its fractions corresponding with the system of weights adopted; and when you have found the equilibrium, observe the weight indicated by the divisions on which each of the weights employed is found, exactly in the same manner as in using the common steel-yard.

There may be seen in the plate a glass shell suspended in a jar filled to a certain height with water. This shell is intended for experiments upon the specific gravity of solids. It is in equilibrium, if, when immersed into water at 59° Fah. as far as the junction of the three silver wires by which it is supported, it exactly balances the weight of the beam unloaded.

To try the specific gravity of a solid, first weigh it in air;

then by putting it into the brass shell, and substituting the glass one, weigh it in water. It is well known that the difference of these weights, employed as a divisor of the total weight in air, gives for the quotient the specific gravity. Care must be taken, as in all experiments of the kind, that no bubble of air adheres to that part of the apparatus immersed in the water, or to the substance, the weight of which is required, and which is immersed also.

The solid glass ball H is used for the purpose of ascertaining the specific gravity of liquids, in the following manner:—This piece is furnished with a hook of fine gold, that it may be immersed without inconvenience in acids. When it is suspended to the hook of the steel-yard, and in the air, it is in equilibrium with the beam loaded at its extremity (either at the division marked O, on the side of the beam seen at F) with weights entitled *specific*, and $\frac{1}{100}$ of specific hooked on at the other.

This ball, immersed in distilled water at 59° Fah. as far as the end of the straight metal wire which suspends it, is still in equilibrium with these two weights placed in the following manner, viz. the large one at the division in the middle of the beam marked *water* on the side F of the beam, and the small one at the division O, that is to say, the extremity. When the apparatus is thus prepared, fill a jar with the liquid, the specific gravity of which is to be ascertained; suspend the ball H to the hook of the steel-yard, and immerse it into the liquid till it rise exactly above the ring from which the ball hangs, observing the temperature, and disengaging carefully all the air bubbles that may adhere to the ball; then remove the small weight to the division O at the end of the beam, and convey the large one as far as that division, preceding that where the weight of the ball would raise the beam; and afterwards move the small weight as far as the division where the equilibrium will be restored, the beam being horizontal. Mark the division at which the large weight is found, and add two ciphers; to this number add the indication immediately resulting from the position of the small weight, and the sum of these two numbers gives the specific gravity of the liquid, or its ratio with the weight of distilled water, to a ten thousandth part.

The balloon N is to be used for trying the weight of any given kind of gas compared with that of atmospheric air, in the following manner:—The weight entitled *air tare* is arranged in such a manner that when placed in the notch, seen at the extremity of the beam beyond the divisions towards B, it forms an

equilibrium with the balloon exhausted by the air-pump and suspended from the hook of the steel-yard. If the steel-yard is not then in equilibrium, it is a sign that the instrument is deranged, or that the vacuum is not perfect. The air, the relative weight of which in regard to atmospheric air is to be ascertained, must be introduced into the balloon, and the weight marked *air* is to be moved along the beam. The division at which it stands when an equilibrium is produced, will indicate, in hundredth parts of the weight of the volume of atmospheric air that could be contained in the balloon, the weight of the gas actually inclosed in it. This indication is read on the anterior part of the beam, where the words *atmospheric air* are marked.

On this principle, pocket steel-yards have been constructed, with which the nicest experiments may be made, and the quality of gold coin be ascertained by the trial of its specific gravity. They are constructed exactly on the same principles as the Roman small steel-yard, but are necessarily less extensive in their use. They cannot be employed, for example, in determining the specific gravity of an aëriform fluid, and do not extend beyond 100 deniers of weight, (about 5¼oz, avoirdupois;) but as they possess all the advantages of a balance, besides those peculiar to themselves, they are extremely convenient for philosophers who are obliged to travel.

SUMMARY OF THE EXPLANATION OF THE PLATE.

AB, the beam of the new steel-yard with its divisions, commencing at the point of suspension. F, the division of the other side of the same beam, commencing at the other extremity, or that farthest distant from the point of suspension. G, a small frame intended to prevent the oscillation of the beam. C, a hook from which the weights are suspended. E, a brass shell or basin. H, a ball of solid glass for trying the specific gravity of liquids. N, a glass balloon for trying the specific gravity of gasses.

Improved Method of Printing Paper Hangings.

In the ordinary method of printing paper-hangings, the tere-boy can with difficulty serve one sieve, but by means of the improvements described below, he can serve two sieves with the greatest ease, and the whole of the work is performed with greater facility and despatch. The following references to plate XXIV, for printing light and dark grounds, will fully elucidate the subject.

METHOD OF PRINTING LIGHT GROUNDS.

Fig. 2. A, the printer's table, covered with a soft blanket.

B, the woollen cloth sieve on which the colour is laid and spread by a boy (called the Tere-boy) with a hair-brush. This cloth sieve is laid upon a leather sieve impervious to moisture, and it floats upon some gum-liquor, in a wooden vessel C.

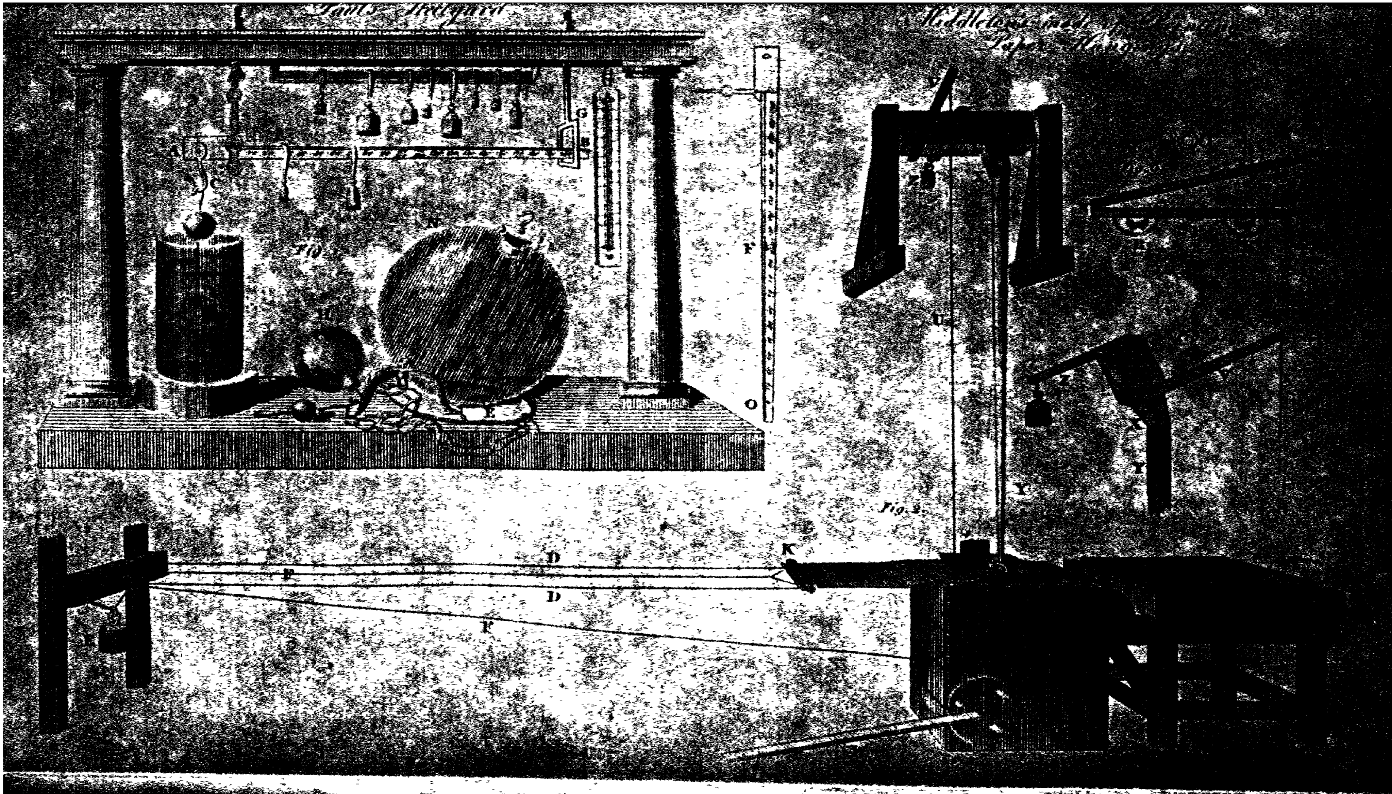
DD, two cords, 36 feet long, stretched from the table A to the other end of the room, and kept tight by a weight at E.

FF, an endless cord, passing round a grooved wheel G under the table, over a pulley H, in the side of the table, and over another I, at the other end of the room. Its use is to carry the cross-piece K, called the *traverse* which is fastened to it.

L, a wheel fixed on the same axis as the wheel G, but on the outside of the boarding of the table, it has three pegs projecting about four inches from its face. This wheel is moved by the printer setting his foot on one of the pegs.

Fig. 3, is the traverse on a larger scale. MM, are two pieces of wood connected by a hinge at N, and when closed are retained in that position by a ring O, put over the ends of them; it is connected with the endless cord, by a staple P on one side, and another staple on the other side, and slides along the cords DD, by means of two pulleys RR.

The operation of printing commences by putting one end of the paper to be printed (which is 12 yards long and 23 inches wide) between the divisions of the traverse, (fig. 3,) and fastening it there by the ring O. The other part of the paper, except what lies on the printing table, is wound round


Fig. 2

the roller S. The workman takes up the printing-block with his right-hand, dips the face of it on the woollen cloth in the sieve, which the tere-boy has previously spread with colour, and then places the block upon the paper to be printed, giving it two or three smart strokes with a leaden mall held in his left hand; he then removes the block, to supply it with more colour from the sieve; and during this operation sets his left foot upon the peg in the wheel; and as he recovers his upright position to bring the block over the table, his foot presses the peg down into the position Q, which by means of the wheel G, endless cord F, and traverse K, draws the paper forward on the table just the proper distance to print again. When the whole piece is printed, the tere-boy goes to the end of the room, loosens the paper from the traverse, and hangs it up to dry in folds, on loose sticks placed across racks attached to the ceiling.

METHOD OF PRINTING DARK GROUNDS.

The table and sieve for the colour are the same as in printing light grounds. The difference of printing consists in applying the colour from the block upon the table, by means of a lever, instead of striking the block with the mall; the pressure of the lever forcing a greater quantity of colour upon the paper and in a more even manner.

T, the axle of the lever.

V, the arm (15 inches long) to which the power is applied by means of a rope U, fastened to it, which has a treadle W at its end, for the workman to place his foot upon.

X, another arm (six inches long) to which is joined Y, a long pole, whose end is applied to the back of the block 3, when the pressure is given.

Z, an arm on the other side of the axle T, to which a weight is hung to balance the pole Y.

Fig. 4, shows a section of the axle T, with the arms V and Z projecting from it, and the manner in which the arm X is connected by a joint with the pole Y; the excellence of this principle depends upon the very great increase of power which is given by bringing the pole nearer the centre of the joint or axis.

The paper being placed upon the table, as in printing light grounds, and the workman having placed his block, furnished with colour, upon the paper to be printed, he puts

his foot upon the treadle W, attached to the cord U, takes the pole from behind the piece of wood 4, and applies its end upon the block 3, and pressing down his foot makes the impression from the block upon the paper. He then lodges the pole behind the piece of wood 4, to be out of the way; he next removes the block to furnish it again with colour, and draws the paper forward for another impression, by the foot-wheel L, as described in the former mode.

Description of the different Methods of blowing up Rocks under Water.

1. The operation of blowing up rocks, which the French call *tirage des mines*, is not in general attended with much difficulty, when the hole of the mine is pierced in dry compact ground without any fissure or cavity. When the ground is cavernous or hollow, or when water oozes through its pores, it becomes more troublesome, and requires particular care. When it is necessary to blow up rocks at the bottom of the water, the difficulties are increased. In that case the usual processes must be abandoned, and others must be resorted to.

2. The art of blowing up rocks under water is little known, and not much practised: it may, however, be of great utility in many cases, not only in the working of mines, but in the execution of public works of importance. These motives will justify a description of the three principal methods of blowing up rocks under water.

The first is that used in the mines in the northern parts of France: it is proper to be resorted to when the depth of the water which covers the ground intended to be blown up is not above 15 or 18 decimetres: (a decimetre is nearly 4 inches Eng.)

The second has a great resemblance to the process usual in mines when the ground suffers the water to ooze through it. It is simpler and less expensive than the preceding, and appears to be very proper in cases when there are only a few decimetres of water above the ground.

The third is suited to great depths of water, such as 4 to 6 metres, (13 to 19¾ feet:) it is that employed at Carlscrona.

It is very ingenious, and seems to be almost unknown to miners in general.

3. But previously to describing these methods, it may be of some use to mention here an interesting memoir, printed in the Journal de Physique for the year 1779, on the construction of air-boats proper for facilitating the execution of all sorts of works under water, without employing pumping. Coulomb, the author of this memoir, after describing the method of constructing the air-boat, shows in what manner it is to be used. He points out the means by which it may be made to sink at pleasure, of placing the workmen under the box, of continually renewing the air, of removing the rubbish and laying a foundation of mason work at the bottom of deep water. He then calculates the time necessary for removing a metre in height from the bank of Quilleboeuf, which interrupts the navigation of the Seine; and foreseeing the cases in which mattocks or pickaxes would be insufficient for clearing obstructions from the bottom of the water, and where the hardness of the rock might require the use of gunpowder, he proposes two methods of blowing up rocks under water.

In one, the workman placed under the box bores the rock, and introduces into the bottom of a hole a box of tin-plate filled with gunpowder, to which is soldered a small tube, also of tin-plate, which rises above the water at ebb-tides, and which is stopped with some greasy matter, after having been filled with a very weak composition to serve as a train. The sea, as it rises, makes the air-boat float; and when its lower edge has risen higher than the extremity of the tube, it is then removed, and when the ebb-tide uncovers that extremity, a person goes in a boat and sets fire to it.

In the other method, which the author proposes for the Mediterranean, and rivers where the assistance of the tide cannot be employed, the tube of tin plate which contains the train rises only three decimetres above the rock, but is terminated by a leather pipe covered on the outside with some water-proof substance, and in the inside with an incombustible varnish, and secured from the pressure of the water by a spiral winding made of wire. Its extremity must be carefully closed, and a buoy attached to it carries it to the surface of the water, when the air-boat is afloat.

4. These methods, which suppose, as may be seen, the assistance of the air-boat, are mentioned because they may be useful in many cases, and may, besides, give rise to new

ideas, and serve to modify the three particular methods which are the object of this memoir.

I. METHOD OF BLOWING UP ROCKS AT THE DEPTH OF FIFTEEN OR EIGHTEEN CENTIMETRES UNDER WATER.

5. This method consists in the following operations:

First, bore the hole at the bottom of the water by the help of bores, and instruments of proper length.

Then place in the hole a tube of tin-plate closed at the lower extremity. The exterior diameter of this tube must be such that, when introduced into the bore, it may fill it; and its length must be such that it shall rise some centimetres above the surface of the water.

Then send down to the bottom of this tube the cartridge filled with powder; introduce the priming rod, and ram round it clay or plaster according to the usual process, and only to the height corresponding to the summit of the hole.

In the last place, draw the priming rod and introduce the train, and set fire to it with all the necessary precautions, that the workmen may be sheltered from the danger at the time of explosion.

OBSERVATION.

6. This method has been often employed with advantage by the French miners: it may serve either for deepening wells, or making other excavations, when the means used for keeping the ground and bottom of wells constantly dry are insufficient.

II. METHOD PROPOSED FOR BLOWING UP ROCKS SOME DECIMETRES BELOW WATER.

7. When the ground or rock to be blown up is covered only by some decimetres of water, the miner can see the rock which he bores, and the hole to be loaded, with as much ease as if there were no water, and can work with the same facility. In this case, to save expense, the tube of tin-plate may be omitted, and a cartridge of pitched cloth, such as that employed in ground through which the water oozes in every part, may be employed, adapting to it a rod of hollow wood,* destined to contain the train that conveys the fire to

* This rod might be made of the elder or honeysuckle.

the powder. The diameter of the aperture of this rod may be only a few millimetres, and its length must exceed the upper level by some centimetres.*

8. If this method be adopted, first construct a cylindric cartridge of cloth or pasteboard, and fill it with gunpowder; insert into it the rod, which must descend to the middle of the length of the cartridge without approaching the interior surface of the wrapper; pinch closely the upper part of the cartridge around the rod, and cover the cartridge and whole rod with pitch or some kind of varnish.† Then send down the cartridge furnished with its rod into the hole of the rock, and drive in strongly two plugs of dry wood to serve as wadding. These plugs must have a longitudinal groove, that they may glide along the rod and suffer the water to escape.

OBSERVATION.

9. Instead of a rod of hollow wood, you may employ with advantage, either a tube of tin-plate about four millimetres in diameter, terminating at a lower extremity, which must be inserted in the cartridge, in a truncated cone, and an orifice of two millimetres: or a leaden pipe drawn in the manner of wire-drawers, having the same dimensions as the above, and whose resistance may be sufficient, if you take care to introduce into it, while you drive in the wadding, a rod which may exactly fill the interior vacuity.

If you have at hand any kind of composition capable of acquiring hardness in a little time‡ at the bottom of the water, you may substitute for the rod and metallic tubes a flexible tube of cloth done over with pitch or gum. In this case, it will be necessary to introduce the priming rod into the tube, while you drive in the wadding to prevent its depression. The cloth of the tube, the upper extremity of which is intended to rise above the hole in the rock, must be sufficiently thick and strong, that the pressure of the water, which is here supposed to be some centimetres above the ground, may not flatten it even if the liquid should introduce itself between the tube and the composition.

---

* Five centimetres make nearly 1 inch. and a millimetre is the tenth part of a centimetre.

† A solution of Spanish wax in alcohol is attended with the advantage of drying speedily, and of remaining water-proof for a long time.

‡ A mixture of quicklime and plaster newly calcined would be of this kind

III. METHOD OF BLOWING UP ROCKS UNDER WATER AT ANY DEPTH.

10. This method, on the first view, has a resemblance to that first described, since a tube of tin-plate is employed in it; but it differs essentially from it in this respect, that instead of wadding above the charge, according to the usual method, you may employ an inflexible shank charged with a weight at its upper extremity, and terminating at the lower in a segment of an iron cylinder, which performs the office of a wedge, and is applied exactly upon another similar wedge, inverted and resting upon the upper end of the cartridge.

The effect of this disposition, as may be readily conceived, is to force the wedge which adheres to the cartridge to ascend a little at the time of explosion, and to squeeze itself closely against the upper wedge, so as to close the hole in the rock.

11. The description of this process may be seen in the twelfth volume of the Memoirs of the Academy of Stockholm; and we subjoin a translation of it.

IV. NEW METHOD OF BLOWING UP ROCKS UNDER WATER, BY DANIEL THUNBERG.

A profile of the rock which has been bored, and into which the charge is introduced, is represented at fig. 1, plate XXV.

The charge is contained in a tube of tin-plate impermeable to water, a vertical section of which is represented in the same figure. The lower extremity of this tube must be adjusted properly to the hole which has been bored in the rock.

The charge consists of a paper cartridge filled with gunpowder, and attached to the iron wedge *b* with a thread such as that used for sewing sails.

To this first wedge *b* is applied another *c*, which adheres to an iron rod that rises above the tube.

On the plane face of these wedges is a groove made with a file, which reaches to the powder: this groove is continued throughout the whole length of the tube of tin-plate by means of a wooden rod *d*, hollow on the side turned towards the iron rod, to which it is made fast by strong packthread.

Before this rod is attached to the iron one, a match, which proceeds from the upper extremity, and communicates with the interior of the cartridge, is placed in the groove.

e Is a train applied to the end of the match.

B, C, are two rafts which enable the workmen to bore the rock and blow it up.

D is a weight which prevents the iron from being repelled too far when the explosion takes place.

E F G H I are different pieces necessary for charging. E is the cartridge furnished with its wedge, seen sideways; F the wedge seen in front; G the wooden rule and its groove; H the upper wedge and its iron rod; I the tube of tin-plate.

When the rock has been bored according to the usual method, by employing a borer pretty strong, and of such a length as the depth of the water may require, introduce into it the tube into which the charge has been put; then apply the train *e*, and having placed the weight D, above the rod, set fire to it. The explosion will immediately take place: the wedge *b* would be expelled but for the wedge *c*, which cannot give way; and the two wedges being thus united, confine the charge, the effect of which will never fail, as has been proved by experience.

Four feet of the tube and the lower wedge are in general lost; but the upper wedge may be employed for new charges, because it is never damaged.

OBSERVATION.

12. This method, the success of which is proved, deserves, no doubt, to be known by all those engaged in great undertakings, and who have frequent occasion to apply it.* It is, perhaps, susceptible of being modified; for example, without employing the impermeable tube, a varnished cartridge might be used, with a flexible tube proceeding from it, lodged in the groove between the two wedges, and then rising above the water.

Fire also might be conveyed to the powder below the water by means of a strong discharge of electricity; but little can be expected from this method in the hands of workmen.

---

* Daniel Thunberg employed the same means to raise large blocks of stone from the bottom of the water. For this purpose a hole is bored in the block with a miner's borer, to the depth of twenty or twenty-five centimetres. Two wedges are introduced into it, forming by their junction a cylinder so as to fill the hole. Several blows are then struck on the iron bar which adheres to the upper wedge: the two wedges are then closely squeezed together, and the block is raised out of the water by means of a windlass and a cord attached to a ring fixed in the lower wedge.

In the last place, the lower wedge might be made of hard and very dry wood.

13. But in whatever manner this method may be employed, it will not require great expense, and it may be used with great advantage for deepening ports, rendering certain harbours more convenient and safe, and for freeing rivers and streams from those rocks which obstruct their course and impede the navigation of them.

Description of a Curvilinear Saw.

A method of easily performing curvilinear sawing, by mechanical means, having been represented to the Author of this invention as extremely desirable, he applied his attention to the subject, and produced the machine of which the following is his description:

Fig. 2, plate XXV, represents a bird's-eye view of the saw and machinery. The dotted lines show the spindle *a*, moving on two centres *b b*, having at one end a pulley *c*, and at the other a concave saw *d* (with a corresponding convexity to the curve required to be sawed,) secured on the convex side by a collar, and on the concave side by a loose collar and screw-nut.

e e, Two grooved plates, admitting through the top of the bench and fence *f*, screw-bolts fastened by thumb-nuts, by means of which, and a parallel motion *g*, the fence *f* is regulated, and consequently the conductor *h* of the wood *i*, admits it to be sawed through, at any part required.

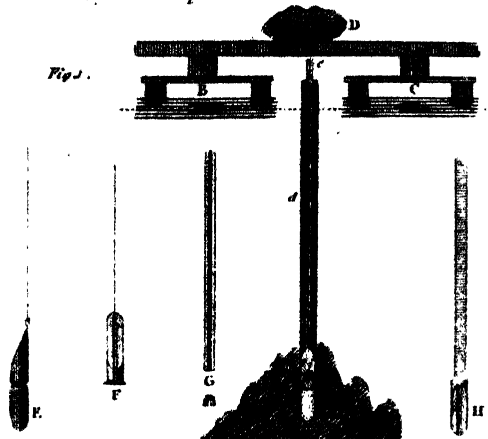
The fence, conductor, and saw, must all be curved alike, but to saw in smaller circles, with the same saw, and at the same time square with the face of the bench, a steel slider *k*, regulated by two screws, is made to press, as occasion may require, on the convex side of the saw, and raise the vertical line of it to a right angle with the bench; otherwise the top of the bench itself must receive the same inclination to the vertical line of the fixed saw.

Fig. 3, is a front view of the saw and bench, in which the teeth of the saw are more clearly shown.

Fig. 4, an end view of the saw and machinery.

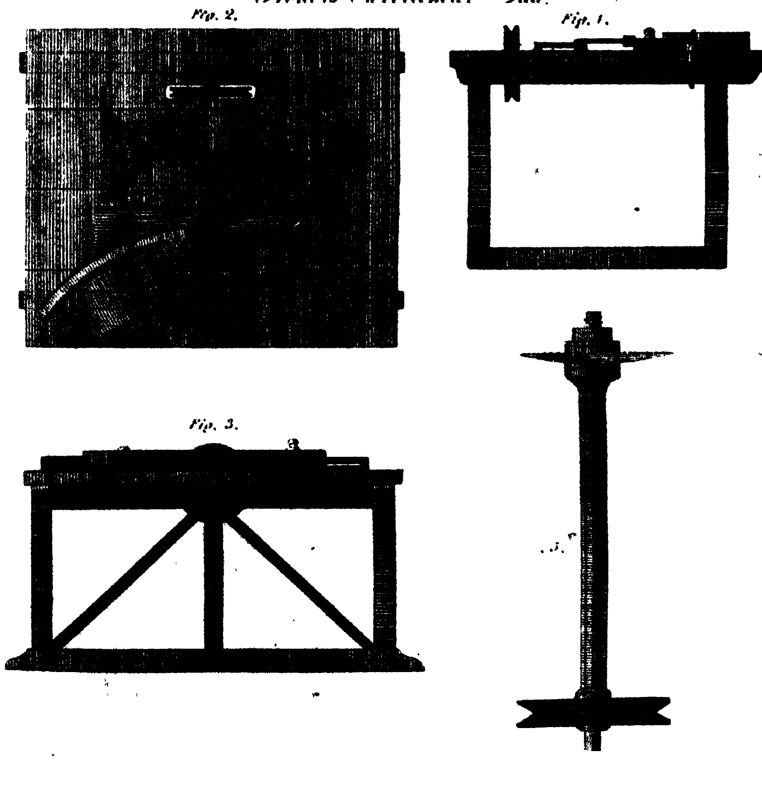
Fig. 5, shows the saw, axle, and pulley, all made of iron or steel, and separated from the frame.

Thunberg's Method of blowing up Rocks under Water.



Scale of the Implements E, F, G, H, I. 5 10 15 Inches.

Trotter's Curvilinear Saw.



A Machine for Hackling Hemp.

For a perspective view of this machine, see plate XXVI, fig. 1. The flax is combed or hackled by three hackles, ABC, (one of which is shown detached in fig. 2,) fixed in the circumference of a large cylinder or drum, which is turned round in the direction from A to B, by the action of a water-wheel, steam-engine, or any other first moving power. The flax or hemp is attached to the square frame E, which moves upon the points of the screws *a b*, as an axis. One end of the parcel of hemp to be hackled is placed between the two pieces of wood *e f*, called hands, shown separately in fig. 3, which are placed on the frame, and held thereto by two screws *g g*, which also draw the two pieces of wood, *e f*, close together, and thus confine the flax or hemp to the frame E. As the cylinder turns round, the ends of the hackles or combs ABC, which project beyond he plane of the cylinder, meet the inclined plane *h* (shown by dots) upon the frame E, and raise this frame upon the centres *a b*, so that the teeth of the hackles can pass by without striking the frame E. The inclined plane now drops off the ends of the hackles, and the hemp falling upon their teeth, as the teeth proceed forwards, they comb it in a manner similiar to the action of the hand.

The end of the axis upon which the cylinder is mounted, has a pinion of eleven teeth fixed upon it, which turns a wheel *i* of forty-four teeth, having a pinion of fourteen teeth fixed to it, and thereby turning a large wheel *k*, of seventy teeth; the axis of this wheel goes through the whole length of the frame, and has at the other end a spiral plate or snail *y*, fixed upon it, which makes one revolution to every twenty of the drum. *l* is the centre of a lever, *m*, one end of which is supported on the snail, while the other forms a stop to the frame E, and prevents it from falling upon the cylinder. As the snail turns slowly round, this lever is alternately elevated and depressed, and by that means the frame E falls gradually nearer to the cylinder, and the teeth of the hackles enter farther into the parcel of hemp suspended from the frame E. The operation of the hackling is begun at the time when the claw of the lever *m*, has just fallen from the largest to the smallest radius of the snail *y*; consequently the end which supports the frame E, is at its greatest height. The two screws *g g*, must then be turned back; the two pieces of wood or hands *e f*, taken away and

opened, as shown in fig. 3, and the end of a parcel of hemp be placed between them; they are now returned to the machine, and the hemp being turned down between the piece of wood *f*, and the cross-bar of the frame E, by tightening the screws *g g*, the hemp will be held tight, so as not to be drawn out by the action of the hackles. The machine is now put in motion, and as the hackles pass by, they lift up the frame E, then let the hemp fall upon the teeth of the hackles. At the commencement of the operation, the hemp falls but a small distance on the points of the hackles, before it is stopped by the end of the lever *m*; by this means the ends only of the hemp are hackled at first, but as the operation proceeds, the snail turns round, and permits the frame E to fall further, that the teeth of the hackles may take deeper hold of the hemp, till at length, when the great cylinder has made twenty revolutions, and the hemp has been hackled sixty times, the snail has raised the lever to the highest, and the teeth of the hackles pass quite through the hemp; and as soon as the lever drops to the smallest radius of the snail, the first operation is supposed to be complete; the machine is thrown out of geer and stopped, and the hemp is unwrapped and reversed, that the other end may be also hackled; and when that is hackled, the whole parcel is removed to make room for a fresh one.

Fig. 2 is a separate view of one of the hackles detached from the cylinder, showing the manner in which it is dovetailed into the cylinder and held by two screws.

A perfect mode of hackling hemp is an object of national importance, from its advantage to the linen manufactory, which has been much cramped by the refractory conduct and [illegible] of hand hacklers. The trials which have been extensively made with this machine, evince its superiority over any mode hitherto adopted. One of its excellences is, that the flax is brought perpendicularly down upon the teeth of the hackles. The hackle also, it will be observed, moves through the flax in the direction of the fibres, and is only suffered to penetrate as the fibres become open or separate. By this circumstance, a great saving in the waste of flax is made, and the flax thus dressed attains a higher degree of [illegible] for spinning. It has been established by experiment, that the saving, by the use of this machine, [illegible] when compared with the same flax hackled [illegible] old way. The machine will dress three hundred weight of flax per day, [illegible] requires not more than two-thirds of the cost in attendance [illegible] hackling by hand.

Davis's Machine for Painters and Glaziers.

Fig. 6.



Fig. 7.

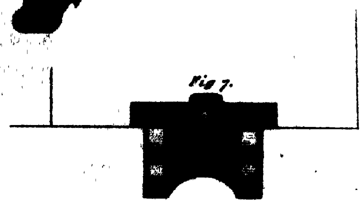


Fig. 8.



Bream's Boiler for Inflammable Materials.

Fig. 4.

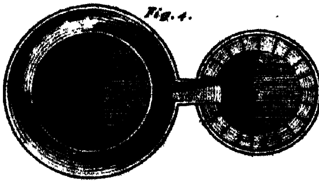
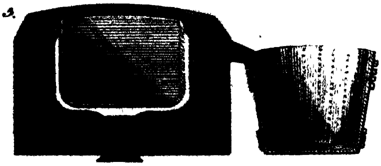


Fig. 5.



Murray's Machine for Hackling Hemp.

Fig. 1.

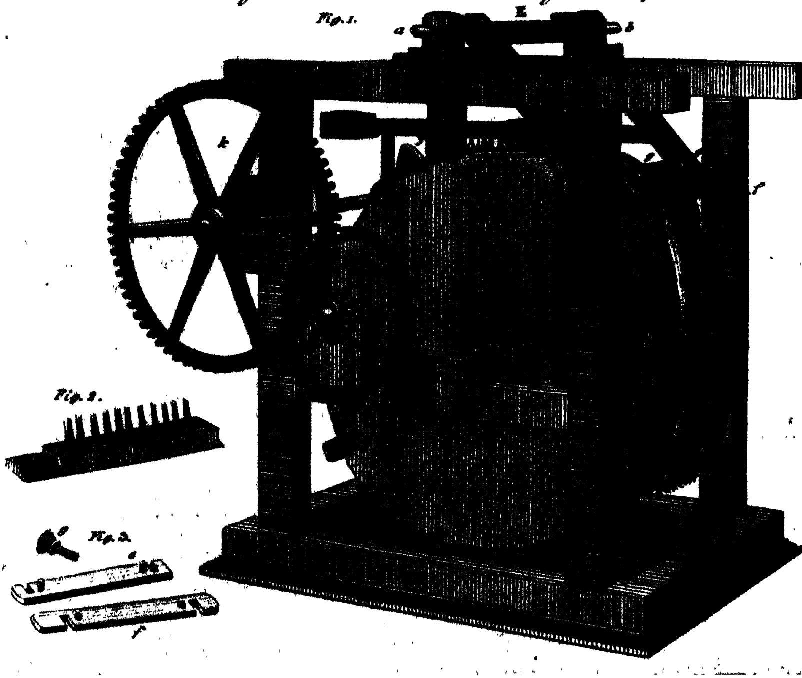


Fig. 2.

Fig. 3.

The machine reduces the dressing of flax to a certainty, which is of material importance in mill-spinning, as flax does not undergo any other separating process after being hackled, but is taken immediately from the hackle to the rollers. No carding can be applied to flax, as to cotton and wool, therefore the necessity of perfect hackling may be easily inferred; and the performance of this machine warrants the hope, that it will enable us to manufacture our finest linen fabrics by machinery at a cheaper rate than at present, by which means a reduction may be effected similar to that which has taken place in cotton manufactures since the invention of spinning cotton by machinery.

A Boiler for the use of Tallow-Chandlers, and other Manufacturers of Inflammable Matters.

The frequent fires which had recently happened in the different manufactories of tallow, soap, oils, varnishes, and other inflammable matters, in various parts of the kingdom, induced the Society for the Encouragement of Arts, &c. in 1809, to publish the following description of a boiler presented to them in 1786, which appears well calculated to prevent the dangerous accidents that often occur from the use of boilers of the common construction.

The very little additional expense that will attend the making of boilers upon this principle, and the great degree of safety secured by the adoption of the plan, may perhaps claim the attention of Government, or of the Insurance offices, to insist upon their use in manufactories of inflammable matters.

Fig. 4, plate XXVI, represents a bird's eye view of the boiler and receiving vessel; the boiler has a double rim containing a channel, communicating by a spout with a vessel below, placed near the side of the boiler. In case the inflammable matter should boil over the inner rim of the boiler, it is received by the channel between the inner and higher outer rim of it, and conveyed immediately by the spout, without risk of loss or damage, into the vessel placed underneath.

Fig. 5 shows a section of the boiler and receiving vessel, in which it will be observed, that the channel which conveys away the fluid that accidentally boils over, is much deeper on the side next the receiving vessel, in order to accelerate the

descent of the boiling fluid into it. The spout should be placed at some distance from the ash-hole and fire-place, for greater security.

A Machine for Manufacturing Silk-covered Wire, and Thread covered with Silk.

The common mode of carrying on the manufacture of silk-covered wire, and thread covered with silk, is attended with several material inconveniences, among which the three following may be specified: — First, it is necessary to have workshops from twenty to forty yards long, consequently the purchase or rent of such premises is a heavy charge upon the manufacturer, particularly in London and all populous places. Secondly, the wire is cut into pieces of the length of the workshop, for the purpose of covering it. Thirdly, the correctness of the work depends upon the steadiness of the workman's hand, and it is therefore liable to frequent irregularities. All these inconveniences are obviated by the use of the machine described below, which may be wrought in a small room, and wire of the length, if required, of several thousand yards may be covered with a certainty of its being regular throughout. Besides these advantages, it only requires one person to work it, whereas in the common mode two are absolutely requisite. The number of wheels, also, might be increased, and arranged in such a manner as to cover several wires at the same time, by which means the despatch of work might be prodigiously accelerated.

The wheels being of the shape of conical pulleys, admit of the work being regulated in the covering to any number of revolutions of silk or cotton round the wire that may be necessary. Their diameters are nearly as follows: viz. on the pulley *b*, plate XXVII, are five grooves, from about three quarters of an inch to one and a half inch in diameter; on A two grooves of twenty-two inches; on E three grooves, from three quarters of an inch to two and a quarter. On F *i h* G and K, from one and a half to nine inches; H from five and a quarter to nine inches; *g* from three quarters to four and a half inches,—all consisting of six grooves each. *m* has four grooves, from one and a half to six inches; *l* four grooves and two ratchet-wheels, all nine inches. The roller D, and two bobbins *n* and B, three inches. The flyer *b d e f* and roller D, receiving their motion

from A and E, always move in proportion one to another, which causes the work to be perfectly regular. The roller D drawing over the raw wire from the bobbin B through the tube which forms the axle of the pulley *b*, where it is covered, and passing round the roller, is taken up on the bobbin *n* by means of the ratchet-wheels *l*. The wheels G and K are for regulating the winding of the wire on the bobbin *n*.

By placing the bands in the different grooves on the wheels *b* F and E, the covering of the wire is regulated to any degree at pleasure, as will be seen by the annexed table of the number of revolutions in one inch of covered wire. The smallest groove is called No 1, the next size larger 2, and the largest 6:

TABLE FOR REGULATING THE NUMBER OF REVOLUTIONS IN ONE INCH OF WIRE.

		b				
		1	2	3	4	5
6 H 6 F	1 F 1 E	153	120	99	86	76
6 H 5 F	1 F 1 E	132	103	85	75	66
6 H 6 F	1 F 2 E	105	82	68	59	52
6 H 5 F	1 F 2 E	90	70	58	51	45
6 H 6 F	1 F 3 E	81	63	52	46	40
6 H 4 F	1 F 2 E	75	58	48	42	37
6 H 5 F	1 F 3 E	72	56	46	40	36
6 H 4 F	1 F 3 E	57	44	37	32	28
6 H 3 F	1 F 3 E	45	35	29	25	22

EXAMPLE I.

Suppose the wire is wanted to be covered 76 revolutions in one inch, place the band upon the wheel A, and on the largest or fifth groove of the pulley *b*; then put the other bands on H 6, and F 1, and F 6, and E 1; it will be 76 revolutions, as will be seen by the table. If the band on A and *b* 5 is removed to *b* 3, it will be 99. Again, if the band is removed to *b* 1, it will cover 153 revolutions in an inch.

EXAMPLE II.

Place the bands on H 6 and F 1, and F 5, and E 2, and *b* 5, it will be 45 revolutions. Again, place the band on *b* 2, it will be 70 revolutions in one inch, and so on for any other number at pleasure.

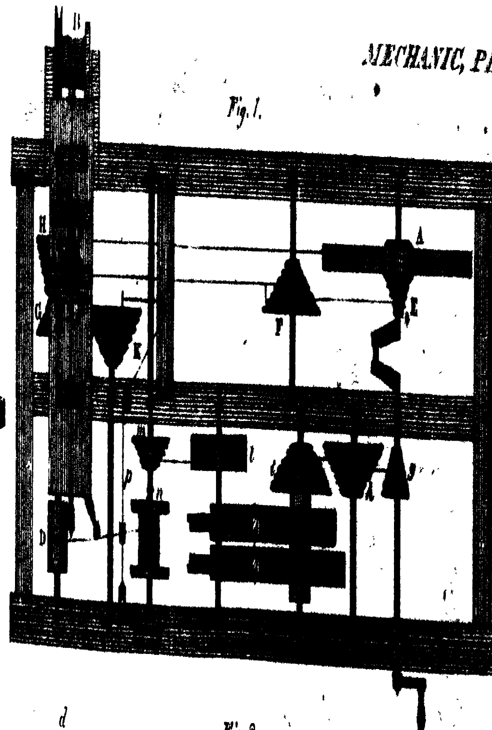
The manner in which the lever is attached to the ratchet-wheel, the Inventor of this machine believes to be new, and he observes that it may be advantageously used in various branches of mechanics, where power with a rotary motion is required, as it avoids the necessity of removing the lever from one hole to another round the axis or windlass. It might be usually employed in raising the masts of barges, &c. or for the purpose of raising weights by acting as treadles.

Fig. 1, is a horizontal plan of the machine. Fig. 2, an elevation taken sideways. Fig. 3, an elevation taken from one end, and fig. 4, is a perspective view of the tube or hollow spindle. The same letters and references are made use of in all the figures.

The great wheel A, fig. 1 and 2, is turned round by the handle on the end of its axis, or by means of a treadle applied to a crank in the middle of its axis. The wheel has two grooves in its circumference to receive a band of catgut, by means of which it gives a rapid rotative motion to the spindle shown in fig. 4, and denoted by *b* in the other figures; the spindle is hollow, and the hole through it receives the wire which is to be covered with silk or thread. A small circular board *d*, fig. 4, is fixed upon the end of the spindle, and turns round with it; it has a small pin projecting from its surface, upon which is fixed a bobbin *e*, having the thread or silk to cover the wire wound upon it. On the opposite side of the centre of the board, a crooked piece of wire *f*, projects from its surface;

Waddingtons Machine for covering Wire with Silk or Thread.

Fig. 1.



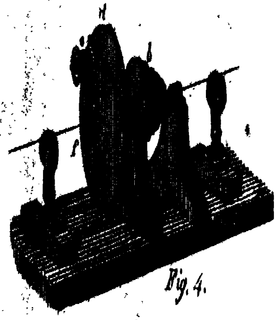


Fig. 4.

Fig. 3.

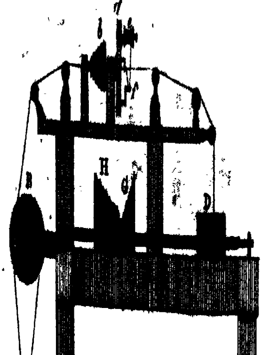
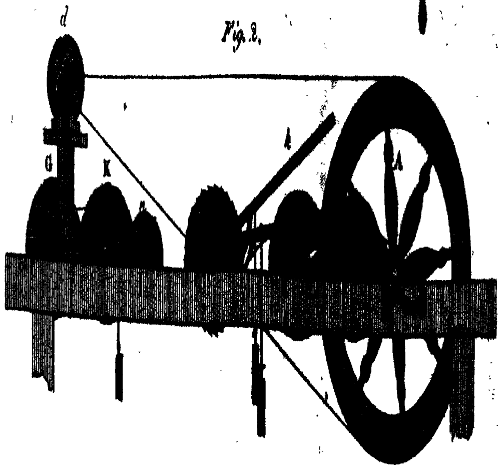


Fig. 2.



Published by Henry Fisher Caxton London 1823

the silk from the bobbin passes over this wire, and is then wound upon the wire which is to be covered, and which, as just mentioned, passes through the hole in the spindle. It is plain that the motion of the spindle will lay the thread or silk evenly round the wire: it is necessary at the same time, that the wire should be drawn through the spindle; this is done by means of a small pulley at *g*, on the axis of the main wheel, having six grooves, turning a larger wheel of six grooves *h*, which gives motion by a band to another band-wheel *i*, of the same size; on the axis of this, two arms, one of which is seen at *i*, fig. 2, are fixed, which alternately move two levers *k k*, fitted on the axis of two ratchet-wheels, whose teeth are caught by clicks with springs fixed to the levers. Two small weights are hung from the levers, as seen in fig. 2, by which the ratchet-wheels have a constant tendency to descend, and as the levers descend, they are raised up again by the arms fixed on the axis of the wheel. On the axis of the ratchet-wheels, a band-wheel *l* is fixed; and by a band which goes round it, and one of the four grooves of the band-wheel *m*, it turns the roller *n*, on which the wire is wound after being covered.

The wire which is to be covered, is first wound upon a roller B, from which, after passing over two pulleys, it enters the spindle of the pulley *b*; it is then covered with silk, &c. and is afterwards conducted over two other pulleys, and passes round the roller at D, and is then wound round the roller *n*: the roller D receives its motion from a band-wheel E with three grooves, on the axis of the main wheel; this turns another band-wheel F, having six grooves, which turns another G of six grooves, on the axis of the roller D. On the same spindle, a band-wheel H of five grooves is fixed, turning another K, which has a pin fixed in it acting as a crank and drawing the catgut line *p* alternately backwards and forwards. This line has a ring in the middle of it, through which the covered wire passes, and by its motion it lays the wire evenly upon the roller *n*. This roller is fixed upon an axis, the end of which is received into a square socket, on the end of the spindle of the wheel *m*. It is contrived, that the roller full of wire may be removed without disturbing the wheel *m*; for this purpose, therefore, the bearing of the end of its spindle is made in three pieces, viz. two outside ones fixed, and the middle one moving on a joint; the end of the spindle passes through a hole, and rests against the middle piece, but when this is turned upon its joint, as shown in fig. 2, the spindle may be drawn back, so as to release it from the socket in the end of the axis in the wheel.

On the Refining of Lead, with Remarks on the Inconvenience of Ash Cupels, and the description of a new and economical Method of constructing Cupels or Refining Vessels.

It is well known that to separate silver from lead, a metallurgic process, called refining or cupellation, performed in a vessel called a cupel, has been employed; it is known also that this vessel is composed either of the ashes of the bones of animals, or of those of vegetables, after they have been lixiviated, to free them from the saline matters which they may contain.

The great quantity of wood ashes which must be employed in the construction of cupels, and the difficulty of obtaining them, long ago induced the Author of this paper, to seek a simpler and less expensive method of constructing the vessels in question. The old chemists having observed that lead becomes oxidated, or reduced into what is called *litharge*, when exposed to heat, or the contact of the atmospheric air, while the silver united to it retains its metallic form, nothing seemed necessary but to find the means of separating these two metals. They were conducted to the method of accomplishing this, by observing that the oxide of lead, in its state of liquefaction, easily penetrates the substances which are in contact with it, and especially bone-ashes, without deforming the vessels which are formed of them. No matter, indeed, is more proper than the latter for constructing small refining cupels.

The difficulty, and often even the impossibility of obtaining about 160 English gallons of ashes for each operation of refining on a large scale in the German furnaces, made the proprietors have recourse to wood-ashes; but, besides that these ashes are expensive, it often happens that they cannot be procured in sufficient quantity. They are even attended with one inconvenience, which is, that they come off, and float on the fused lead; the refining then fails; and this takes place every time that the ashes are badly prepared, that the cupel is insufficiently or not uniformly beat, or when the canals destined for the evaporation of the moisture, are neither in sufficient number, nor properly arranged, nor covered with a stratum of scoria, on which is established the bottom that

receives the ashes, and which ought to be constructed of the most porous bricks, in order that the water, with which it is necessary to moisten the ashes, may penetrate them in evaporating, may proceed to the bed of scoria, and escape by the channels which are at the base of the furnace.

To ascertain the proportion of lead in silver, it is sufficient to put some pennyweights into a small cupel of bone-ashes placed under the muffle of an assaying furnace. In proportion as the lead becomes oxidated, it insinuates itself into the cupel, and the silver at last assumes that vivid appearance which announces that the whole of the lead is dissipated, that the silver it contained is refined, and has attained its maximum of purity.

In refining on a large scale, the object also is to separate the silver from the lead, but not to make the whole of the latter penetrate into the cupel, which is even impossible; for in that case it would be necessary to have a much larger quantity of ashes for the total absorption of the metal: besides, the operation would require a period ten times as long as that used in general for refining, and would occasion ten times the expense in fuel, and a much greater loss of the metals than by the usual process, where the greater part of the lead is obtained in litharge, while a portion penetrates into the cupel for about two inches of its thickness, which must be fused to revive the lead. The reduction is also more expensive, and occasions a greater loss than that of the litharge, which is easily fused, and which, passing through the furnace, may be employed as an article in commerce.

Lead ore and litharge may be fused as in England, and the department of Brittany, in a reverberating furnace, the soles or basins of which are formed of pounded and moistened clay. These soles withstand the action of heat, and of the oxide of lead, for six or eight months of uninterrupted use.

The durability of these earthen soles gave the first idea of the method hereafter proposed for refining furnaces, where the only thing required is to oxidate the lead to obtain it in litharge, and not to cause the cupels to imbibe the whole of it, as is done when the object is to assay the metal, in order to know whether it contains silver. In operating on a large scale, the cupel, though of ashes, absorbs only a part of the lead, as already mentioned, observing at the same time, that it would be much more advantageous to obtain the whole transformed into litharge, the reduction of which into lead is much easier than that of the oxide contained in the ashes,

which oppose fusion, and the scoria of which always carries with it some of the metal.

In a cupel of ashes beat into an oval circle of iron, the greater diameter of which is only five or six feet, and the less one yard, the English refine from a ton to 23 cwt. of lead, which is converted into beautiful litharge, except the small portion which penetrates into the cupel, the thickness of which is only about 2½ inches, and which is supported under the arch of the furnace by two bars of iron. A pair of leather bellows drive the litharge towards the interior part of the furnace, from which it falls without interruption, on the floor of the foundry, while, to fill up the vacuity left by the oxide running off, an ingot of lead placed close to the base of the bellows, is made to advance gradually into the interior part of the furnace. This lead, by fusing, keeps the cupel full till towards the end of the operation.

If a short view has here been given of the process of the English, it is only to show that it is possible to perform operations of refining by employing only a small quantity of ashes for the construction of cupels. Those in question do not absorb 90 pounds of oxide in the large quantity of lead which is refined.

It is then proved that metallurgists have always endeavoured to obtain the greatest quantity possible of litharge, and little ashes impregnated with oxide; but as they thought that they ought not to deviate from the ordinary process of refining, they have always constructed their cupels of ashes.

It has been seen, that in cupellation on a small scale, lead, in proportion to its oxidation, penetrates the ashes. When no more is left, the small button of silver remains pure at the bottom of the basin, under a spherical form. This operation takes place with the more celerity, as the surface of the mass is always convex in these small vessels; which allows the oxide to flow as on an inclined plane, towards the edges of the cupel, where it is immediately imbibed.

The case is not the same with cupels on a large scale, which are several yards in diameter: to these, bellows must be applied, the wind of which serves not only to accelerate the oxidation, but also to drive the litharge towards the gutter formed for its escape.

We have remarked the inconveniences, and even the impossibility of making the whole lead penetrate into the ashes of large cupels: oxidation, indeed, is not effected but in the parts of the mass exposed to the contact of the air or to

the wind of the bellows; but as litharge, towards the middle of the basin, could not reach its edges, it would remain there in a state of stagnation, and would necessarily oppose the formation of a new stratum of oxide. This has induced metallurgists to expel the litharge by the wind of a pair of bellows in proportion as it is formed, and to make it flow from the furnace.

'Oxidation then takes places only at the surface of the mass, and not at its lower part: if the case were otherwise, the ashes of cupels would be penetrated by the oxide to a thickness the more unequal, as the operation is longer; but the *test*, or the part of the ashes impregnated with litharge, in refining on a large scale, never appears to be thicker in the centre of the basin than towards its circumference, though the lead remains thirty or forty times as long on the bottom as on the edges; since the mass continually decreases, till the whole lead is reduced to litharge, and till nothing remains but a cake of silver at the bottom of the cupel.

If the whole lead is imbibed by the assaying cupel, it is because this small vessel is exposed to a heat uniform in all its parts. As the cupel, in operations on a large scale, presents to the action of the fire only its upper surface, the oxide imbibed ceases to penetrate it at the place where the temperature is no longer high enough to keep that oxide in a state of fusion. For this reason, the thickness impregnated is equal throughout the whole extent of the cupel; and this prevents the possibility of making the whole lead penetrate into the ashes.

From the above observations it may be easily conceived, that if the assaying of lead ought to be performed in small cupels of bone-ashes, in order that the oxidated metal may penetrate them, and be in part evaporated, the case is different, with refining on a large scale, where it is necessary to accelerate the operation, and to obtain as much litharge as possible.

It has been already said, that the wood-ashes of which cupels are made for refining on a large scale, are expensive; that very often a sufficient quantity cannot be procured; and that besides this, part of the ashes, and sometimes the whole, separate themselves entirely from the sole; from which a considerable loss arises. It may be added, that to give more weight and consistence to the cupels, it is often necessary to mix with the ashes a large quantity of sand; especially if the lead contains foreign substances, such as arsenic, cobalt, anti-

mony, tin, &c. If the lead be only arsenical, after having separated the first scum, a quarter of a hundred-weight of iron filings, or cast iron turnings, are now and then thrown over the whole surface of the mass. The iron being lighter than lead, floats over it and absorbs the arsenic, after which the mass must be scummed: soon after the litharge is formed without any obstacle. This method is employed in Saxony.

The necessity of adding sand to the ashes of cupels, must have conducted to the discovery of the means proposed below:

NEW METHOD OF CONSTRUCTING BASINS FOR REFINING.

Without making any change in the mason-work of the refining furnace, called the German, care only must be taken to form at the bottom a sufficient number of canals for the evaporation of the moisture, and to arrange them in the manner best calculated to produce that effect. These canals or apertures must be covered with a bed of scoria, over which a pavement is to be made with one layer of the most porous bricks.

On this area, which must be concave like the sole on which the ashes of common cupels are beaten, place founders' sand a little moistened; to which may be added a fifteenth part of argil, if it is not sufficiently earthy, in order to give it the requisite solidity: and the whole must be carefully mixed. This sand must be rammed in the same manner as for consolidating ashes; and a refining basin is to be formed in like manner, uniformly beat in all its parts. The thickness of this cupel must be six or seven inches: it may be formed of two strata, as will be seen hereafter.

After the basin has been uniformly beaten in every part, about a gallon of lixiviated wood ashes may be sifted over its whole surface, and rendered adherent with beaters.

When the cupel is thus prepared, let down the head on the furnace, and make a moderate fire in the fire-hole, which must be maintained for several hours, in order to cause a part of the water, with which the sand has been moistened, to evaporate. The surplus will be dissipated during the operation, without any inconvenience, by canals of evaporation.

After a sufficient desiccation, raise the head, and suffer the cupel to cool a little; spread out straw or hay over it, and arrange the ingots of lead, placing them gently on it, that their weight may not derange the sand: it is to prevent such

derangement that straw is employed, as is done in regard to cupels of bone-ashes.* When the quantity of lead necessary for filling the cupel is arranged in the furnace, let down the head, and having luted it round with soft clay, make a fire in the fire-hole, as for the common operations of refining.

When the lead is in complete fusion, and the mass is covered with scum and charred straw, make the scum or dross run off by the gutter for the litharge, with a bit of board about a foot in length, in the middle of which is fastened a rod of iron of sufficient length to traverse the furnace and about a yard more.

When the lead has been well scummed several times, and begins to be red, make the bellows act, but at first gently; arrange the nozzles of them in such a manner, that the wind issuing from both may be directed to the centre of the cupel; and in order that the wind may always be reverberated on the mass, adapt to the extremity of each nozzle a small round piece of iron plate. This kind of valve, which the French refiners call *papillon*, is employed in refining according to the German method. They are suspended by hinges at their upper part: at each stroke of the bellows, they are half raised, and they reverberate the wind on the lead, which accelerates its oxidation.

After all the dross or scum is removed, and when the lead has become exceedingly red, and covered with a stratum of litharge, form, with a small iron hook destined for that purpose, a small gutter in the sand of the cupel, which must be dug deeper, gradually and with caution, until the bottom of it be on a level with the mass. The litharge then, driven by the wind of the bellows towards the anterior part of the furnace, will run by this gutter and fall on the floor of the foundry, as is the case in the common operations of refining.

When the refiner observes that no more litharge remains in the neighbourhood of the gutter, he will stop the flowing off with a small quantity of moistened ashes: but as soon as the lead again becomes covered with oxide, the gutter must be opened, and must be dug in proportion to the diminution of the mass, taking care that no lead escapes, and particularly towards the end of the operation: for it would carry with it a great deal of silver, which would be lost. You must

* Instead of prismatic ingots, it will be better to cast the lead in hemispherical iron moulds: pieces of that form are less liable to damage the cupel.

proceed in this manner till the silver has acquired its vivid colour; taking care to increase the fire in proportion to the diminution of the mass; especially when the operation is nearly terminated, because the silver then is collected together: and, as it is much more difficult to be kept in fusion than the small quantity of lead which remains united with it, it could be refined only in an imperfect manner at an insufficient temperature; and instead of about a twentieth of lead, which the silver generally contains in the German refining-houses, it would remain charged with a great deal more, which would render it more difficult to proceed in a second operation called the *refining of silver*, by which it is carried to the required degree of purity. The Germans call this second process *silber brennen*, burning silver.

Those accustomed to the refining of lead, according to the German method, will be able to perform what is here proposed; for, though the cupel be of sand instead of ashes, the operation must be conducted in the same manner.

It has been said that the English refine a large quantity of lead in a small cupel: in the like manner, a great deal of metal may be made to pass by this new method, if care be taken to add more metal as that which is oxidated escapes. If we suppose that the cupel is capable of containing four or five tons of lead, above sixteen may be refined at one operation; which will not be attended with the inconveniences of the English process.

The Author has reason to think, that a cupel of sand, well constructed, may serve for several operations with ut the necessity of reconstructing it each time, as is the case with those of ashes; but in this case, and before the lead is introduced, you must fill up the gutter which has been made for the litharge to run off, after having removed with a chisel the kind of varnish which the oxide of lead has left on the sides of it, in order that the new sand, somewhat moistened, may form an intimate connexion with the old sand, which must also be watered in that part, before the new sand is deposited.

The long duration of earthen soles in reverberating furnaces, where lead-ore and even litharge are fused, leaves no room for apprehension, in regard to the action of the oxide of lead, which will act only at the surface of the cupel, and will penetrate only a very small part of its thickness.

After one or more operations of refining, this crust must be removed, and fused in a furnace in contact with fuel, in

order to obtain the lead. This process will be as easy as the reduction of that metal contained in the ashes of common cupels, and in a much smaller quantity. More litharge then will be obtained by the new method than the old. It may be added, that as the sole of sand does not absorb so much oxide of lead as that of ashes, it will not carry with it so much silver, for it is well known that lead revived from its ashes, always contains more than that which arises from the reduction of litharge.

Instead of sand, argillaceous earth might be employed for the construction of cupels, as is the case in regard to the soles of the reverberating furnaces in Brittany; but it would be necessary to ram this earth repeatedly, for several days; otherwise it would split, and these cracks would increase by the shrinking which must result from the heat, and lead would insinuate itself into these fissures; an inconvenience which cannot take place with sand even a little earthy. It may also be observed, that a sole of earth would harden too much to allow a gutter to be dug for the passage of the litharge: in this case it would be necessary that the place destined for the oxide to run off should be constructed with sand or lixiviated ashes.

It will be advantageous to employ two kinds of sand in the formation of the basin of the cupel; one kind fine like that used by founders, and the other coarser and not earthy: the latter will form the first stratum, which, after being beat with rammers suitable for that purpose, ought to be about three inches and a half in thickness. The fine sand, a little earthy, must then be applied over this first stratum to form a second, which is to be rammed like the former. Both these kinds of sand must be somewhat moistened before they are introduced into the furnace, in order that they may be better heaped up, and be consolidated by the rammers.

The sand of the lower stratum, being coarser than that of the upper, will absorb the moisture of the latter in proportion as it evaporates: and it will pass without any obstacle through the canals disposed for that purpose.

The lowest stratum of sand may remain in its place when a new cupel is to be constructed with fine sand, and the part of the latter, which has not been impregnated with oxide, must be mixed with new sand to form a cupel. Care must be taken in raising this sand not to touch the lower stratum; for the sand of the latter, which is coarse, must not be mixed

with the other. This inconvenience may be avoided by beating over the bed of coarse sand a thin stratum of ashes, at which you must stop in removing the fine sand of the upper stratum.

It has been said that the founders' sand must be somewhat earthy, and that, if it is not, a little argil must be added to give it cohesion: but as it is necessary that this argil should be uniformly diffused through all the parts of the sand, it must be diluted in the water with which the sand is moistened, and the whole must be carefully mixed.

It may be objected, that as cupels of sand do not absorb so much litharge as those of ashes, more time will be required to terminate the operation of refining; since, in the new process, the oxide, instead of being absorbed, ought to flow from the furnace. This circumstance need excite no uneasiness, for the wind of the bellows, if well directed, will make the litharge flow along the gutter more abundantly than if there had been an absorption.

Some refiners in Germany, in constructing their cupels of ashes, form in the middle of them a small circular depression, the diameter of which is proportioned to the quantity of silver which they know to be contained in the lead subjected to the operation. By this excellent disposition no grains of that valuable metal remain insulated from the cake; the whole runs into the central basin, and forms a cake perfectly round. This practice deserves to be imitated.

The Author is certain, that the cupels here proposed, if carefully and properly constructed, will be attended with complete success; will be free from the inconveniences of those of ashes, and at the same time will be economical. He is desirous, for the benefit of metallurgy, that the method here pointed out may be put in practice: it will prove that we ought not to be too tenacious in adhering servilely to ancient usages, or to the common routine of workmen.

Machine for making Slate-Pencils.

The inventor of this machine having been informed that an immense quantity of slate-pencils were annually imported into this kingdom, under the name of Dutch pencils, and aware that there was, near his residence, an inexhaustible quarry of that species of shale or shiver peculiarly suitable for this branch of manufacture, on the mountain called Black Combe, in the seigniory of Millom, Cumberland, conceived the idea of employing the leisure which his occupation in husbandry allowed him, in contriving a machine for manufacturing pencils that should rival in cheapness, and excel in other respects, those procured from foreign markets. He completely succeeded in his attempt, and the sale of his pencils, though at first only extended to a few of the large towns in Cumberland, Westmoreland, and Lancashire, soon occasioned a greater demand than he was able to supply, while the machine was only impelled by hand. At this time, the long pencils were sold at ten shillings, and the short ones at five shillings per thousand, and the machine, while wrought by manual labour, made about twelve hundred of the two sorts per day.

The manufacture of an article of this kind, may appear, at first view to have a very slight claim to attention: but when it is considered that there is a great and constant demand for such pencils in every village in the kingdom, the aggregate consumption will be perceived to be immense. This consumption was supplied by foreign markets, till the products of the machine in question were brought forward; but even if this were of no consequence, the art of expeditiously shaping a pencil, must be considered as an ingenious mechanical operation and capable of affording hints applicable to other purposes.

It may be observed, in giving a general idea of the machine, as now employed, that it is worked by a water-wheel of seven feet in diameter, fixed on one end of the axis; a small lever, projecting from the axis, presses down the jaws of a pair of pincers, the lower handle of which pincers is made fast below the axis above mentioned, and the upper handle is alternately pressed down by the lever, and raised by a crank at its extremity, which is counterbalanced by a weight above it. These pincers first cut the shale or shiver into proper lengths or slips, which slips are carried from thence, and one by one entered into the end of a circular sharp-edged tool or tube, bearing

some resemblance to that with which saddlers punch holes in leather. The slips of the stone are forced through this tube by means of another lever fixed in the axis of the water-wheel, which alternately presses forward the frame sustaining the pencil, and draws it back, after having given the pressure, by means of a wedge and wheel fixed upon another axle. The pencils are made in a circular form, by passing through the tube above-mentioned.

Plate XXVIII, fig. 1, exhibits a perspective view of the machine. AA is the axis or shaft of a water-wheel, which gives motion to the machinery; *a a* are two cams or tappets projecting from the axis to work the nippers or pincers B.

The lever *x*, which is part of the lower jaw of the pincers, is lifted up by two rods which connect it with a heavy lever or counterbalance *b*, and by this means the nippers are opened; the upper jaw is fixed to a post firmly placed in the ground. As the water-wheel revolves, the cams *a a* alternately press down the lever *x*, and close the nippers; and when the cam has passed by, the weight of the lever *b* opens them again. L is another cam, much larger than the former, (fixed into the same shaft AA,) for giving motion to the other parts of the machine.

DD are two cylindrical rods, connected by the cross-pieces, EFG, which form a frame; the rods DD slide through holes or sockets in two beams *d d*, fixed to the frame of the machine; between these two beams, an iron plate H is fixed; having a hole in the middle, to receive the screw of the cutting tube, a section of which is shown by fig. 2.

The frame is pushed away from the axis A, by the cam L meeting the cross bar E of the frame, and it is brought back again by the cam moving a crooked lever *e e*, which is fixed on an axis R.

II are two segments of wheels, fixed on the same axis with R; two chains *k k*, are fastened to these, and passing over two pulleys *l l*, are fastened to the front piece E of the frame; by these chains, the motion of the crooked lever, *e e*, is communicated to the frame, so as to draw it back, ready for the next stroke of the cam L.

M is a cross bar, moving upon two centres, having a notch or gap in the middle of it, for one end of the shiver or piece of slate to rest upon. At one end of this bar is an arm, to which is hooked one end of a beam or weight, the other end resting upon the ground. The frame in its action presses down this cross-bar, but it is again replaced in its upright position by the action of the weight upon it.

Brockbank's Machine for making Slate Pencils.

Fig. 2.

Section

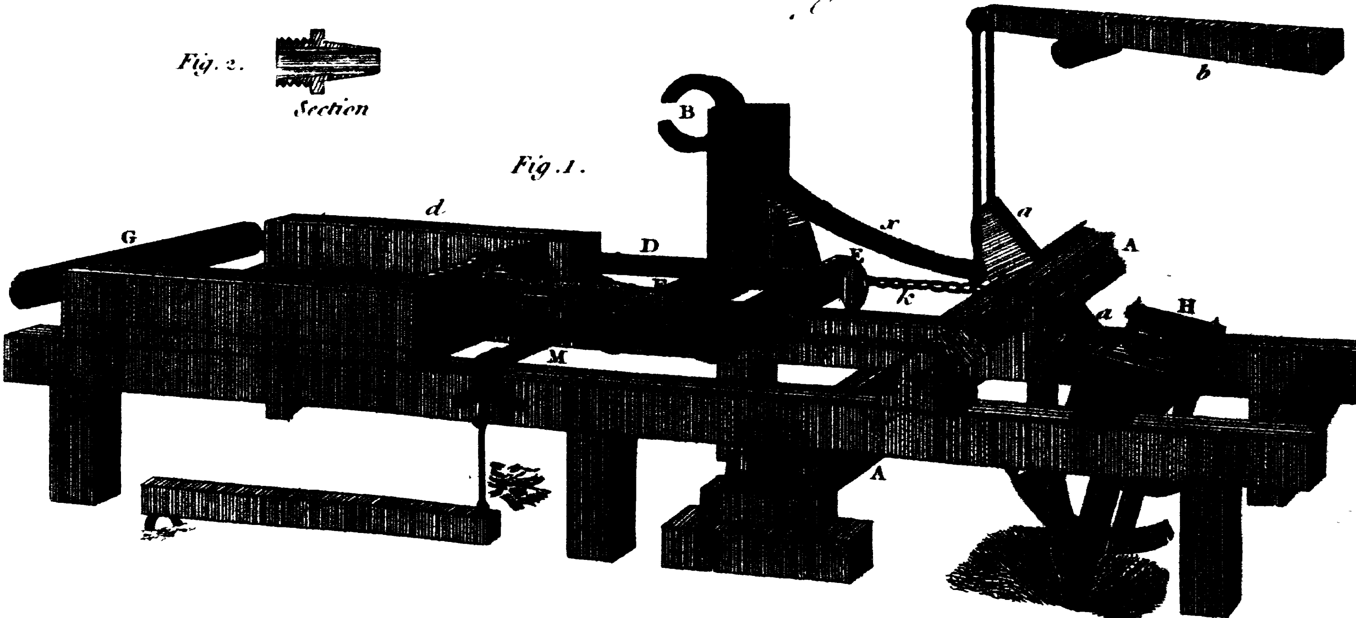


Fig. 1.

J. Smith Liverpool. Sep.r 1815.

The material of which the pencils are made, being laid in a convenient place, (the person employed generally sitting to his work,) in the first operation of the mill, the pincers B very expeditiously pinch or split it into slips or lengths, which are received by a person attending the frame, and successively placed so as to have one end in the cutting tube, and the other end in the notch of the cross-bar M; the revolution of the water-wheel now forces the frame forward, and forms the pencil, by thrusting the slips or lengths before-mentioned through the cutting tube which is screwed into the iron-plate H, the chips or refuse slate falling down under the cutting tube. The pencils are then in their second stage, and in order to reduce them to a proper size, and finish them, the first cutting tube is unscrewed or taken out, and another, the size of the intended pencil, is fixed in its place; they are forced through this smaller cutting tube, by the same operation as before, and the slate pencil is then completely finished, being rendered a smooth and beautiful cylinder.

The two screws *r r*, which either advance or draw back the cross piece F, are to regulate the forcing frame, that all the pencil may be forced through the cutting tube, when the cam L, upon the axis of the water-wheel AA, leaves the forcing frame. A water-wheel only seven feet in diameter, has sufficient power to work both the pincers and the forcing-frame at the same time; and boys are adequate to the attendance required.

The cutting tube should be made of the best steel, and hardened; the pencil will also pass through more easily, if it gradually widen in a small degree towards the back.

It would be extremely easy to have two or three cutting tubes screwed into the iron-plate H, and used at the same time, and thus the quantity of work done by the machine would be greatly increased; but it might be necessary, if this plan were adopted, to have the lengths of the pencil-stone cut in readiness, or to have two pair of pincers to supply them as they were required.

A Pentrough, for equalizing the Water falling on Water-Wheels.

In all mills worked by water, some inconvenience is found to arise from the irregularity of speed, occasioned by the variation of the head of water at the pentrough. The specific weight being necessarily proportioned to the perpendicular altitude of the water, its velocity is increased by a greater, and diminished by a less head. No accurate judgment as to the quantity really admitted, can be formed from the position of the shuttle. The space only is regulated by this; but the quantity of water passing through that space, depends on its specific gravity, in proportion to which its course is accelerated: besides, where the race is of any considerable length, the rain-water which falls into it, and that which gains admission from the adjoining lands, baffles all calculation, as to the quantity really passing into the dam or reservoir; and the shuttles at the dam head are subject to the same evil. Any irregularity in the head of water falling on the wheel, is of course communicated to the internal machinery; and occasions inconvenience in all manufactories where precision in the movements is requisite, and particularly those of silk and cotton.

To give an even, regular motion to water-wheels, appears therefore to be a disideratum in hydraulics. Perhaps it can only be obtained by equalising the quantity of water falling on the wheel; but while the usual system is pursued, of delivering it from the bottom of the pentrough, it does not appear easy to suggest means by which all irregularity can be prevented.

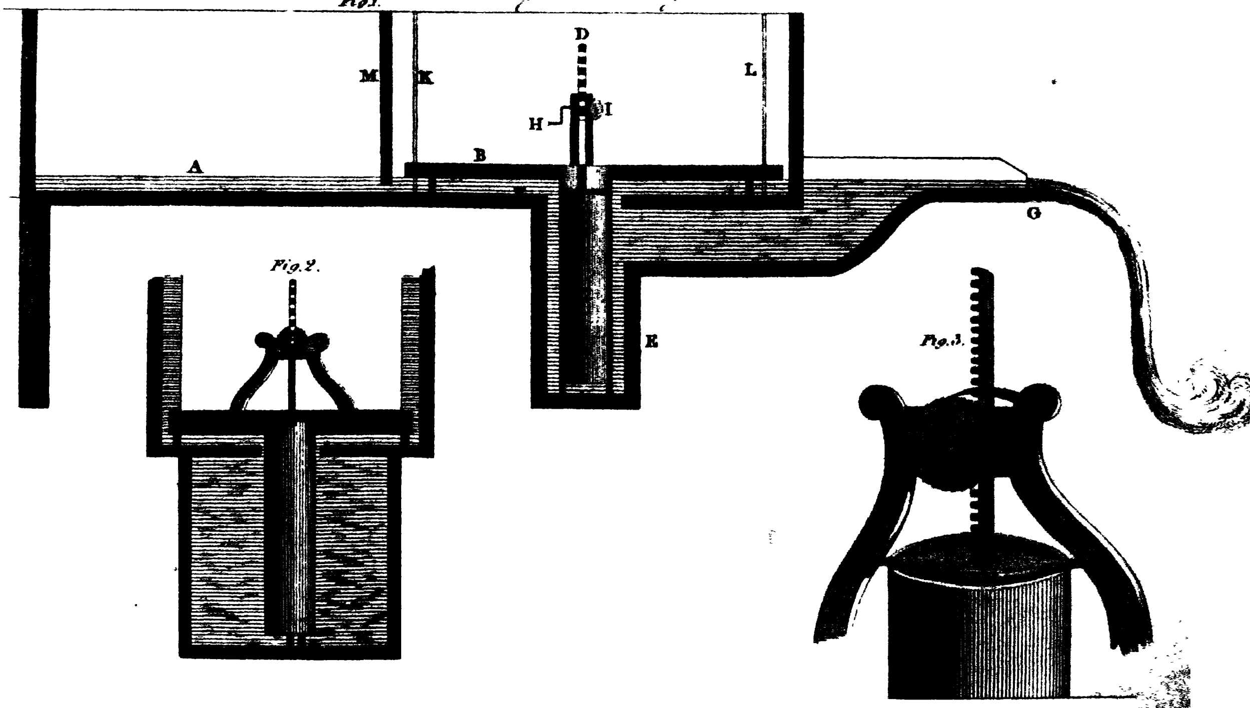
In order to remedy this inconvenience, and ensure a constantly regular supply of water on the wheel, it appeared to the Inventor of this pentrough, that means might be devised of regulating the quantity delivered by a float, and taking the whole of the water from the surface. After several experiments, he found the performance of the machine described below, to accord with his expectations.

A, fig. 1, plate XXIX, the entrance of the water.

B, the float, having a circular aperture in the centre, in which is suspended

C, a cylinder, running down in the case E, below the bottom of the pentrough. This is made water-tight, at the

Quayle's Pontivagi.



Published by Henry Fisher Caxton London 1823.

bottom of the pentrough, at F, by a leather collar placed between two plates, and screwed down to the bottom.

The cylinder is secured to the float, so as to follow its rise and fall; and the water is admitted into it through the opening in its sides, and there, passing through the box or case E, rises and issues at G, on the wheel. By this means, a uniform quantity of water is obtained at G, which quantity can be increased or diminished by the assistance of a small rack and pinion attached to the cylinder, which will raise or depress the cylinder above or under the water line of the float; and, by raising it up to the top, it stops the water entirely, and answers the purpose of the common shuttle. This pinion is turned by the handle H, similar to a winch-handle; and is secured from running down by a ratchet wheel, at the opposite end of the pinion-axis.

K and L are two upright rods, to preserve the perpendicular rise and sinking of the float, running through the float, and secured at the top by brackets from the sides.

M, a board let down across the pentrough, nearly to the bottom to prevent the horizontal impulse of the water from disturbing the float.

Fig. 2, a cross section, showing the mode of fixing the rack and pinion, and their supports, on the float. The rack is inserted into a piece of metal running across the cylinder, near the top.

That the water may pass more freely, when nearly exhausted, the bottom of the cylinder is not a plane, but is cut away, so as to leave two feet, as at C, fig. 1.

The float is also kept from lying on the bottom of the pentrough, by four small feet; so that the water gets under it regularly from the first.

Fig. 3, an enlarged view of the cylinder, showing the rack and ratchet-wheel, with the click, and one of the openings on the side of the cylinder; the winch or handle being on the opposite side, and the pinion, by which the rack is raised, inclosed in a box between them.

By the use of this shuttle, room may be saved in the extent of the dam, as the water may be suffered to rise to a greater height, without the inconvenience attending the increased velocity of its discharge. In cases, also, of temporary deficiency, the water which remains will, by this means, be worked to the greatest advantage.

Machine for splitting Sheep-skins.

The art of splitting a skin of leather which is required to be made thinner, instead of cutting away a part of it in shavings of no value, possesses a degree of ingenuity and utility that entitles it to notice in this collection of inventions. The purpose is effected by a machine represented by plate XXX.

Fig. 1, A, the barrel of cast iron, having wooden ends. Round this barrel the skin is wrapped, and kept close by means of pins run through the edges into the wood, as at *e e e*, fig. 2.

B (fig. 1) an iron running in a groove along the barrel, catching in a hole at C, and fastened down at the other end, by a hook fixed in the end of the barrel, the bar having points in it, (as shown at B, fig. 3,) under which the edges of the skin are fastened, as seen at D, fig. 2.

FF, (figs. 1 and 2,) bars fixed across each end of the strong wooden frame GGGG, over which the barrel is supported on friction rollers, as at *h h*, (fig. 2,) which run on a slip of brass, moveable under the screws *i i*, to adjust the barrel to the knife.

KK, (figs. 1 and 2,) a strong bar of cast iron, to which the knife is screwed, moving lengthwise on friction rollers between the pieces of wood LLLL, on the frame G, as at K, fig. 4. The pieces of wood LLLL, are each moveable under two screws, by which they are adjusted to steady the motion of the knife-bar.

MM, (figs. 1 and 2,) is a roller at the back of the knife, to which it is kept close by a weight N, at each end, acting over pulleys, as at O, (fig. 2,) suspended from the sliders *p p*, between which the roller is placed. By drawing the spare skin over this roller, as it is cut off, it keeps both sides of the skin equally up to the knife, and makes it cut more uniformly.

QQ, is a lever acting on a pin *r*, and moving another lever SS, by means of a pin and a notch T, which acts on another pin at U; and by means of the two pins at W, it moves the knife lengthwise to and fro. As fast as the skin is cut, the barrel is drawn round by the weight X.

Y, is a guide to the lever, from which end it is worked.

Stotts Machine for Splitting Skins.

Fig. 3.

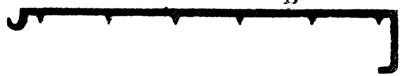


Fig. 1.

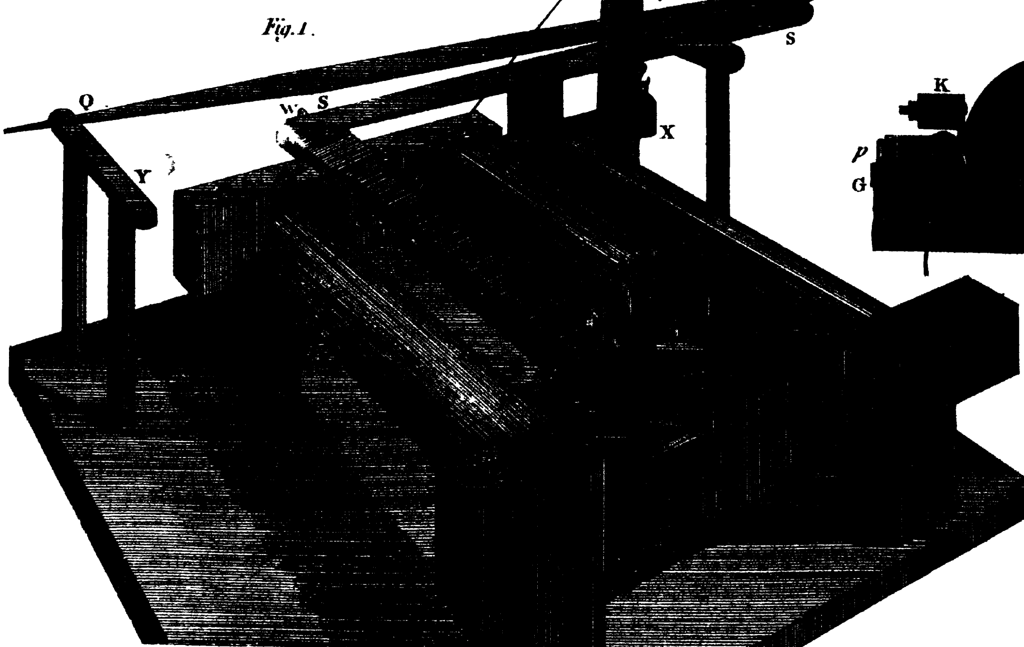


Fig. 2.

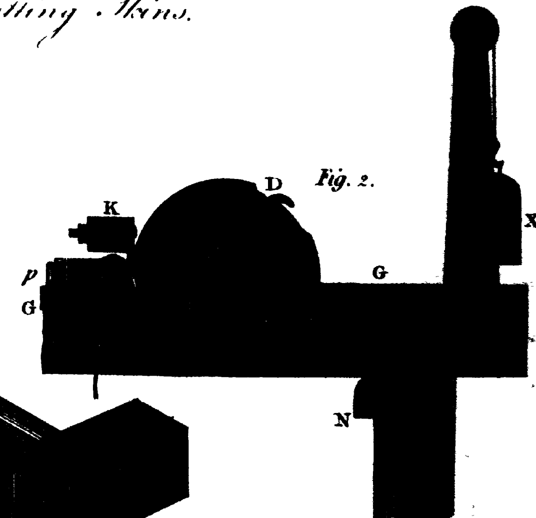
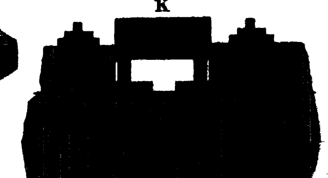


Fig. 4.



Preparation of Grounds or Pannels, and of various Colours and Materials, for Painters.

The Inventor of the various processes detailed in this article, has been employed in preparing canvass, pannels, &c. by some of the most eminent professors of the fine arts, in Italy and England. He states that, by a number of experiments, and after much labour and expense, he has discovered, as far as experience can prove, the manner of preparing canvass, copper, and pannel, in the old Venetian style; an art which has been long lost, and to which, it is well known, that Titian, P. Veronese, Bassani, and other Venetian masters, owed the peculiar beauty, brightness, and durability of their productions.

He observes, also, that he has discovered a method of purifying oils for painters' use, agreeably to the practice of the ancient masters; and prepares mineral colours which will not change, and may be used either in oil or water. He has likewise been enabled to produce crayons, of a quality greatly superior to those in common use; they are fixed, so as to prevent their rubbing off the paper when used, and may be applied in water or oil.

The materials employed in these preparations, are extremely cheap, easy to be procured, and the processes by no means difficult.

METHOD OF PREPARING PANNELS FOR PAINTERS.

Take the bones of sheep's trotters, break them grossly, and boil them in water, until cleared from their grease, then put them into a crucible, calcine them, and afterwards grind them to powder. Take some wheaten flour, put it in a pan over a slow fire, till it is dry, then make it into a thin paste, add an equal quantity of the powdered bone-ash, and grind the whole mass well together: this mixture forms the ground for the pannel.

The pannel having been previously pumiced, some of the mixture above-mentioned is well rubbed thereon with a pumice-stone, to incorporate it with the pannel. Another

coat of the composition is then applied with a brush upon the pannel, and suffered to dry, and the surface afterwards rubbed over with sand-paper.

A thin coat of the composition is then applied with a brush, and if a coloured ground is wanted, one or two coats of the colour is added, so as to complete the absorbent ground.

When it is necessary to paint upon a pannel thus prepared, it must he rubbed over with a coat of raw linseed or poppy-oil, as drying oil would destroy the absorbent quality of the ground; and the painter's colours should be mixed up with the purified oil hereafter mentioned.

Canvass grounds are prepared by giving them a thin coat of the composition, afterwards drying and pumicing them, then giving them a second coat, and lastly a coat of colouring matter, along with the composition.

The grounds thus prepared do not crack: they may be painted upon a very short time after being laid, and from their absorbent quality, allow the business to be proceeded upon with greater facility and better effect, than with those prepared in the usual mode.

METHOD OF PURIFYING OIL FOR PAINTING.

Make some of the bone-ashes into a paste with a little water, so as to form a mass or ball; put this ball into the fire, and make it red-hot; then immerse it for an hour in a quantity of raw linseed oil, sufficient to cover it; when cold, pour the oil into bottles, add to it a little bone-ash, let it stand to settle, and in a day it will be clear and fit for use.

WHITE COLOUR

Is made by calcining the bones of sheep's trotters in a clear open fire, till they become a perfect white, which will never change.

BROWN COLOUR

Is made from bones, in a similar manner, only calcining them in a crucible instead of an open fire.

YELLOW COLOUR, OR MASTICOT.

Take a piece of soft brick, of a yellowish colour, and burn it in the fire ; then take for every pound of brick, a quarter of a pound of flake white, grind them together, and calcine them ; afterwards wash the mixture, to separate the sand, and let the finer part gradually dry for use.

RED COLOUR, EQUAL TO INDIAN RED.

Take some of the martial pyrites usually found in coal-pits, calcine them, and they will produce a beautiful red.

GRAY COLOUR

Is made by calcining together blue-slate and bone-ashes powdered, grinding them together, afterwards washing them, and drying the mixture gradually.

BLUE BLACK

Is made by burning vine-stalks in a close crucible, in a slow fire, till a perfect charcoal is made of them, which must be well ground for use.

CRAYONS

Are made of bone-ash powder mixed with spermaceti, adding there the colouring matters. The proper proportion is, three ounces of spermaceti to one pound of the powder. The spermaceti, to be first dissolved in a pint of boiling water, then the white bone-ash added, and the whole to be well ground together with as much of the colouring matter as may be necessary for the shade of colour wanted. They are then to be rolled up in the proper form, and gradually dried upon a board.

WHITE CHALK,

If required to work soft, is made by adding a quarter of a pound of whiting to one pound of the bone-ash powder ;

otherwise the bone-ash powder will answer alone. The coloured chalks are made by grinding the colouring matter with bone-ashes.

On the Art of imitating Carved Wood.

Ingenious or curious men are often thwarted in the execution of their projects, by the difficulty of finding in the places where they reside, workmen capable of assisting them in the articles for which they may have occasion. Small towns in particular furnish only indifferent workmen; and besides, they do not contain artists of every kind. Good carvers, for example, reside only in large towns; and even in these are not very common. Sometimes plasterers supply the want of good modellers, by incrusting in their decorations plaster moulded on excellent models. The Author of this memoir conceived that it might be possible to mould carving in wood, to be afterwards applied to cabinet-makers' work. This idea he carried into execution, and though the art is not absolutely new, his experiments may afford useful hints to others.

Wishing to obtain a case for a pendulum clock he had constructed, he drew a plan of it, and presented it to an excellent cabinet-maker in the small town in which he resided. The artist would only undertake the plain work, and referred him for the execution of the carving to Toulouse or Bourdeaux. Sensible how difficult it would be to get the carving of the different pieces executed at a distance, and particularly within the required time; and how expensive it would be to transport such a case, which might also be damaged by the way, he determined to undertake himself the carving of the laurel and oak foliage which were placed in the plan, provided the cabinet-maker would undertake the remaining part. Fearing, however, that the carving would not correspond to his work, and might tend to degrade it, the artist was unwilling to undertake any thing till he had seen a specimen of the Author's labour—a proposal which was agreed to.

The Author was well aware that very hard wood, such as box, might be moulded by putting it under a press in copper moulds, after having subjected it to certain preparations: but for this purpose very expensive moulds, an excellent press

and other conveniences, are required, the obtaining of which would occasion considerable expense, and by this method bas-reliefs only can be executed. But the art about to be described, requires only cheap materials with very little practice, and affords the means of making not only figures in relief, but even the most difficult objects of sculpture.

In the town where he resided, he found one of those Italians who employ themselves in moulding plaster figures. He caused this man to make such moulds as would be required, and which were copies from the best masters. Having succeeded perfectly in moulding the garlands thus furnished, in walnut-tree wood, the Author showed them to his cabinet-maker, who took him for an able sculptor. He then constructed the case, applied the foliage, and neither he nor any person who saw it had the least suspicion of the method which had been employed. All believed that the ornaments had proceeded from the chisel of an able carver. Since that time, the Author moulded for his friends bas-reliefs, trophies, &c. with wood of every kind. The following is his process:

PROCESS.

Make very clear glue with five parts of Flanders' glue and one part of fish-glue, or isinglass. Dissolve these two kinds of glue separately in a large quantity of water, and mix them together after they have been strained through a piece of fine linen, to separate the filth and heterogeneous parts which cannot be dissolved. The quantity of water cannot be fixed, because all kinds of glue are not homogeneous, so that some require more and some less. The proper degree of liquidity may be known by suffering the mixed glue to become perfectly cold: it must then form a jelly, or rather a commencement of jelly. If it happens that it is still liquid when cold, a little of the water must be evaporated by exposing the vessel in which it is contained to heat. On the other hand, if it has too much consistence, a little warm water must be added.

The glue thus prepared is to be heated till you can scarcely endure your finger in it: by this operation a little water is evaporated, and the glue acquires more consistence. Then take fine raspings of wood or saw-dust, sifted through a fine hair-sieve, and form it into a paste, which must be put into moulds of plaster or sulphur after they have been well rubbed

over with linseed or nut-oil, in the same manner as when plaster is to be moulded. Care must be taken to press the paste into the mould with your hand, in order that it may acquire all the forms of the mould: then cover it with an oiled board, and, placing over it a weight, suffer it in that manner to dry. The desiccation may be hastened and rendered more complete by a stove. When the impression is dry, remove the rough parts, and if any inequalities remain behind, they must be smoothed, after which the impression may be affixed with glue, to the article for which it is intended. Then cover it with a few layers of spirit of wine varnish, as is done in general in regard to carved work, or use wax in the encaustic manner. It requires much attention to discover that such ornaments are not carved in the usual manner. Gilding may be applied to them with great facility. This operation is exceedingly easy; nothing is necessary but moulds; and with a little art the ornaments may be infinitely varied.

Busts and other figures may be moulded with complete success: but they require more care, and with a view to economy, when they are large, the interior of them may consist of a cheaper composition than the exterior. The process may be thus conducted: make a paste similar to the former, with very fine saw-dust, and place a stratum, of about two lines in thickness, on every part of the mould; this stratum may be left to dry almost entirely. In the mean time a coarse paste prepared with saw-dust that has only been made to pass through a coarse sieve; and instead of Flanders' glue, common glue may be employed, which is less expensive, adding to it a sixth part of fish-glue. Two parts of the mould may be put together, after introducing into the joints a slight stratum of the fine paste, made very clear and applied with a small brush. The vacuity between the two pieces may be filled up with coarse paste. Apply a third piece in the same manner as the second, and so on until the whole is adjusted, always filling up the vacuities with coarse paste. The whole must be suffered to dry in the mould, and thus will be obtained a figure in relief, of solid wood, executed with all the delicacy of plaster figures. The prominences formed by the joinings may be removed by a sharp knife, or small file. If the figure be not suffered to dry too much, these prominences may be easily removed with the point of a sharp penknife. It will be necessary to learn the art of determining the proper degree of desiccation; for if the figure be taken from the mould before it is properly dried, it will warp,

and if it be too dry, it cannot be corrected but with a file, the use of which instrument in this case is tedious and laborious; whereas, if the proper moment be seized, the paste may be cut like wax; especially if the saw-dust has been fine, which is necessary for the exterior layer. The figures may be completely dried in a stove, by which means they will acquire a degree of solidity hardly to be conceived. Figures thus moulded may be bronzed or varnished: they will then be unalterable by the effects of moisture or dryness.

It has already been said that Flanders', and not common glue, ought to be employed for the exterior layer, because this glue is almost colourless;* whereas the other, being dark-coloured, gives too obscure a tint even to walnut-tree wood. To try whether the moulded figures would be unalterable by the effects of moisture or dryness, the following experiments were made:

EXPERIMENT I.

In a large bell-glass, filled with atmospheric air, were exposed two figures, one of which was varnished, and the other not. Under the bell, was placed Saussure's hygrometer, and a capsule filled with water, after the sides of the bell had been moistened. The air was soon saturated with water, and the hygrometer indicated 100 degrees. No alteration whatever was observed in the varnished figure, and the other exhibited no other sensible alteration, than a commencement of solution in the glue, so that on applying a finger to its surface it was found to be somewhat viscid; in a word, the figure was not in the least warped.

EXPERIMENT II.

The two figures and the hygrometer were then introduced into another very dry bell, under which had been placed a capsule filled with calcined potash. The moisture of the air by which the figures were surrounded, was soon absorbed, and the hygrometer indicated zero. In order to ascertain whether the

* A suitable glue may be made, by boiling shreds of parchment, or the white leather prepared with alum.

whole moisture imbibed by the unvarnished figure was entirely dissipated, every thing was left in *statu quo* for four hours, the hygrometer still indicating zero. The two figures were then taken out, and neither of them had experienced the least alteration.

EXPERIMENT III.

The first experiment was repeated, with a view to cause the two figures to absorb as much moisture as possible; and when the hygrometer indicated 100° they were taken from the bell, and suddenly introduced into a stove, the heat of which was 144° of Fahrenheit. The unvarnished one became dry without cracking, and the other showed a little softening in the varnish. This effect may be ascribed to the imperfect desiccation before the experiment, for the softening was more considerable than is generally the case when a varnished body is exposed to heat.

These experiments appear sufficient to warrant the conclusion, that imitations of moulded wood, according to the process here described, are unalterable by moisture or drought, for in our climates the thermometer never rises to 144°. Figures thus made have the solidity of wood, and are even preferable to it: for a slight blow given to wood, if cut across the fibres, will detach some of the parts; whereas figures formed of artificial wood, are homogeneous throughout, and are not easily broken.

Besides the advantages which this invention on the first view exhibits, it offers others which may be of general utility to our arts and manufactures.

1st. In the large manufactories of mirrors, the ornaments in general are in a very bad taste, and miserably executed, because the carvers are very ill paid. If this new method be adopted, sculptors would pay more attention to their first work: they would mould their ornaments in plaster or in sulphur, then take a multitude of copies with the greatest facility, and these ornaments would add to the value of our furniture.

2d. Inlayers would make much more elegant works by employing pastes of differently coloured woods, which might be managed with greater ease than the thin pieces of coloured boards which they employ. The Author is now engaged with some experiments on this subject, and it is his intention to make small tablets to imitate mosaic; the result of his labour, he has promised to communicate to the public.

Method of preparing White Lead without injuring the Workmen.

In order to explain the advantage that will accrue to the workmen, from adopting this invention, in preference to the common mode of preparing white lead, it will be proper to state what the common mode is. When blue (metallic) lead is corroded in the stacks, by an acid raised to a considerable degree of heat, brought on by horse litter, the corroded and uncorroded lead are taken from the stacks to a room called the engine-loft, where a pair of iron rollers is fixed with a screen under them. The lead in this state is passed through the rollers and screen; from the motion of these rollers and screen, by which the white lead is separated from the uncorroded or blue lead, together with the moving of the lead in order to its being passed through them, a very considerable quantity of white lead rises and spreads itself on every side in the form of a fine dust, which almost covers the workmen thus employed, and is very pernicious to them. And not only in this part of the process are they liable to be thus injured; but they are again exposed to the dusty lead, by removing the blue lead from the screen-house to the furnace, as there still remains a quantity of the fine particles of white lead, which of course rises in the removal; and in removing the white lead also from under the screen to the grinding-tub, a quantity of the dust arises, which is very detrimental to the people so employed.

It is to obviating these causes of mischief, that the present invention applies in the following manner:—A vessel, shown in plate XXXI, fig. 1, is provided, twelve feet long, six feet wide, and three feet ten inches deep. In this vessel is fixed a pair of brass rollers in a frame, one roller above the other: the centre of the rollers is about ten inches below the top of the vessel; and one inch lower is a covering of oak boards or riddles, an inch thick, fixed in the inside of the vessel in a groove, so as to be taken out occasionally: these boards are bored with a centre-bit as full of holes as may be, without danger of breaking into each other; these holes are, in the machine at large, about five-eighths of an inch in diameter. This being done, the vessel is filled with water about three inches above the oak boards or riddles; the lower brass roller is now under water, and about half of the upper roller is under water

also: thus the lead coming from the stacks is put through the brass rollers in water, and by raking the lead with a copper rake over the oak boards or riddles, the white lead passes through the riddles, and the blue lead remains above; the blue lead being taken out, is thrown upon an inclined plane of strong laths to drain, where it remains about twelve hours, when it becomes ready for the furnace, to be remelted. By this means no dusty white lead can rise in any part to the work people. It may be asked, why the lead in the common mode is not made wet before it is passed through the rollers and screen? Should this be done, the lead would be a paste on the rollers and screen, and the white lead prevented separating from the blue lead, which is absolutely necessary in the preparation of white lead.

Fig. 1, A is an inclined plane of wood, on which the white and blue lead are placed immediately from the stacks, and thus introduced between the brass rollers BB.

CC, the vessel containing the water.

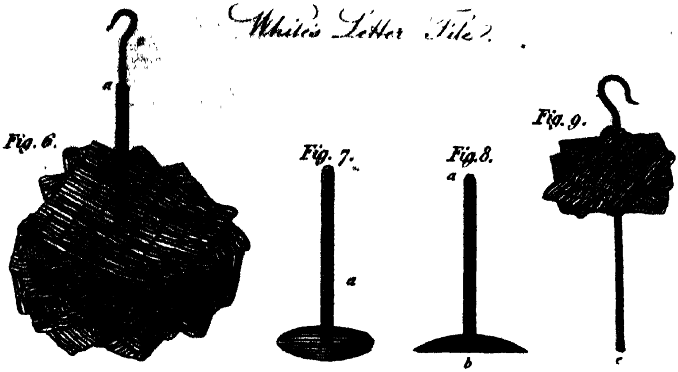
DDD, the pierced oak boards or riddles, which, by being made to slide in grooves in the sides of the vessel CC, may occasionally be taken out by removing the wooden bar *e e*.

E, a handle or winch, which in the machine at large, may be a wheel communicating with the mill-work, and thus turning the rollers BB.

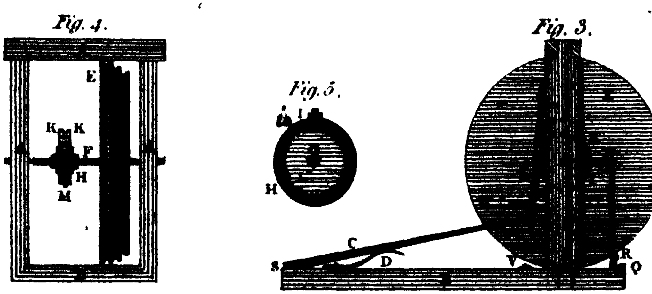
F, a pinion fixed on the axle of the upper roller, and communicating with a similar pinion on the arbor of the lower roller, keeping both of them in motion by the turn of the handle. As it is necessary that the upper roller should be at liberty to rise or fall, in order to give a due degree of pressure to the lead in passing between the two rollers, two weights, GG, with proper stems to them, (as shown more at large in fig. 2,) are placed over the axle or gudgeon of the upper roller, to produce a due degree of pressure; and if any piece of the lead should be thicker than usual, the roller gives way to it, and thereby the injury of the machinery is prevented.

H, a notch on one side of the wooden vessel, serving to regulate the depth of the water on the riddles DDD.

White's Letter File.



Ridley's Substitute for a Crank.



Ward's Machine to prevent the rising of Dust in the Manufacture of White Lead.



Explanation of the Principles on which the Purification of Fish-oil may be performed, and of the Uses to which it is applicable.

That the fetid smell of fish-oil is chiefly owing to putrefaction, it is unnecessary to show; but, though this be the principal cause, there is another likewise, which is, ustion, or burning the oil, occasioned by the strong heat employed for extracting it from the blubber of the large fish, and which produces a strong empyreumatic scent that is not always to be equally removed by the same means as the putrid smell, but remains sometimes very prevalent after that is taken away.

In order to the perfect edulcoration of oils, there are consequently two kinds of fetor or stink to be removed: viz. the putrid, and the empyreumatic; and the same means do not always equally avail against both.

The putrid smell of fish-oil is of two kinds: the rancid, which is peculiar to oils; and the common putrid smell, which is the general effect of the putrefaction of animal fluids, or of the vascular solids, when commixed with aqueous fluids.

Fish-oil has not only rancidity, or the first kind of putrid smells peculiar to oils, but also the second or general kind; as the oil, for the most part, is commixed with the gelatinous humour common to all animals, and some kinds with a proportion of the bile likewise: and those humours putrefying, combine their putrid scent with the rancidity of the oil, and, in cases where great heat has been used, with that and the empyreuma also.

The reason of the presence of the gelatinous fluid in fish-oil, is this; that the blubber, which consists partly of adipose vesicles, and partly of the membrana cellulosa, which contains the gelatinous fluid, is, for the most part, kept a considerable time before the oil is separated from it, either from the want of convenient opportunities to extract the oil, or in order to the obtaining of a larger proportion: as the putrid effervescence which then comes on, rupturing the vesicles, makes the blubber yield a greater quantity of oil than could be extracted before such a change was produced; and the vesicles of the tella cellulosa, containing the gelatinous matter, being also burst from the same cause, such matter being then rendered saponaceous by the putrefaction, a part of it mixes

intimately with the oil, and constitutes it a compound of the proper oleaginous parts and this heterogeneous fluid.

The presence of the bile in fish-oil is occasioned by its being, in many cases, extracted from the liver of the fish; which is not to be so profitably done by other means as by putrefaction and the bile being consequently discharged, together with the oil from the vessels of the liver containing them, combines with it, both from the original saponaceous property of bile, and from that which it acquires by putrefaction.

This holds good particularly of the cod-oil, or common train, brought from Newfoundland, which from its high yellow colour, viscid consistence, and repugnance to burning well in lamps, manifests sensibly the presence of bile and the gelatinous fluid; which latter, by the saponaceous power of the bile, is commixed in a greater proportion in this than in any other kind of fish-oil.

A tendency to putrefy, or at most but in an extremely slow manner, is not an absolute property of perfect oils in a simple or pure state, but it is a relative property dependent upon their accidental contact or commixture with the aqueous fluid. This is evident from the case of oils concreted into a sebaceous form; which, being perfectly oleaginous and uncombined with any water, except such as enters into their component parts, will not putrefy, unless water, or something containing it, is brought into contact with them. But the fluid animal, and most vegetable oils, being compounded of perfect oils with other mixed substances, either sub-oleaginous or gelatinous, have always a putrescence *per se*, or tendency to putrefy, without further admixture of aqueous moisture. This commixture of heterogeneous matter in fish-oil, particularly of the gelatinous fluid and bile, gives rise to a further principle of purification than *simple edulcoration*, or the removing the fetor; for the presence of such humours in the oil renders it subject to a second putrescence *per se*, supposing the first corrected; makes it unfit for the purpose of the woollen manufacture, as the heat through which this is in some cases employed causes this matter to contract a most disagreeable empyreuma. It also prevents its burning in lamps, as well from its viscidity as from the repugnance which the presence of water gives to all oleaginous matter. It is therefore necessary to free the oil from this heterogeneous matter; after which it can be subject only to the rancid putrescence, or that which is proper to oils as such.

The substances which have been or may be applied to the removing or preventing the effects of putrescence, are, acids, alkalies, metallic oxides, neutral salts, ethereal and essential oils, vinous spirits, water, and air. With respect to acids, though they may be applied with effect to the removal or prevention of putrefaction in mixed animal and vegetable substances, yet they have not the same efficacy when employed in the case of oils; for in a small proportion, without the subsequent aid of alkalies, they rather increase than diminish the fetor, and in a large proportion they coagulate the oils, and change their other properties as well as their consistence. Though they might therefore be employed with the assistance of alkalies, yet requiring a more expensive and complex process, and not being moreover necessary, as the same end may be obtained by the use of alkalies only, they may be deemed improper for the purification of animal oils for commercial purposes. Alkaline substances, both salts and earths, are the most powerful instruments in the edulcoration of oils: but as their action on putrid oils, and the method of applying them to this end, are not the same in both, it is proper to consider them distinctly.

Of alkaline salts it is the fixed kind only which are proper to be used for the edulcoration of oils. Fixed alkaline salts, in a dissolved state, being commixed with putrefying animal substances, appear to combine with the putrid matter, and, mixing with some of the principles, form instantly volatile alkaline salts. On the less putrid they seem to act, after their combination, by an acceleration of the putrescent action, till they attain the degree which produces volatile salts. This is evident by the sensible putrid ferment and smell which appear after their commixture; but which gradually abating, the oil is rendered sweeter, much lighter coloured, and thinner.

Their great use in the edulcoration of fish-oil arises therefore from their converting such parts of the gelatinous fluid and bile as are highly putrefied instantly into volatile salts, and causing a rapid putrefaction of the other parts; by which means the oil is freed from them by their dissipation. They do not, however, equally act on the parts of the oil on which the empyreumatic scent depends, unless by the assistance of heat; for when they are commixed with the oils without heat, in proportion as the putrid smell diminishes, that becomes more sensibly prevalent. The ultimate action of

lixiviate salts on animal oils, except with respect to the empyreuma, seems to be the same either with or without the medium of heat; for the same urinous and putrid smell, gradual diminution of the colour, and fetid scent, happens in one case as in the other, except with regard to the acceleration of the changes; and such salts, where the purification is required to be made in a great degree, are a necessary means, as they are more effectual than any other substance that can be employed.

The use of lixiviate salts alone is not, however, the most expedient method that can be pursued for the edulcoration of oils, for several reasons. If they be used alone, cold, in the requisite proportions, they coagulate a considerable part of the oil, which will not again separate from them under a very great length of time; and when they have destroyed the putrid scent, a strong bitter empyreumatic smell remains. The same inconvenience, with relation to the coagulation of part of the oil, results when they are used alone with heat. The super addition of common salt (which resolves the coagulum, and counteracts the saponaceous power of the lixiviate salt, by which the oil and water are made to combine) is therefore necessary; and the expense arising from the larger proportion of lixiviate salt, requires it to be employed if no other alkali be taken in aid, and renders the junction of alkaline earths with it extremely proper in the edulcoration of oils for commercial uses. Lime has also an edulcorative power on animal oils: but it has also so strong a coagulative action, that the addition of a large proportion of alkaline salts becomes, when it is used, necessary to reduce the concreted oil to a fluid state; and therefore this substance alone is not proper for that purpose. The combination of lixiviate salt with lime, or the solution commonly called soap-ley, has an effectual edulcorative action on fetid oils; but it makes a troublesome coagulation of part of the oil, if no common salt be employed, and must be used in such large proportion, if no alkaline earth be added, as renders the method too expensive.

Lime has a power of combining with and absorbing the putrid parts of the gelatinous fluid and bile when commixed with oil, and effects, either with or without heat, a considerable edulcoration of fetid oils; but it combines so strongly with them either cold or hot, that the separation is difficult to be effected even with the addition of brine; and the oil, when a large proportion of it is used, can scarcely be at all

brought from its concreted to a fluid state, but by an equivalent large proportion of lixiviate salt: the use of lime, therefore, alone, is improper, or even in a great proportion with other ingredients. But when only a lesser degree of edulcoration is required, a moderate quantity conjoined with an equal or greater weight of chalk, which assists its separation from the oil, may, on account of its great cheapness, be employed very advantageously: it will in this case admit of precipitation from the oil by the addition of brine. It may be also expediently used when lixiviate salt is employed with heat for the most perfect purification of oils; for it will in that case give room for the diminishing of the quantity of lixiviate salt, though the proportion be nevertheless so restrained as not to exceed what the proportion of lixiviate salt (just requisite for the edulcoration) can separate from the oil.

Chalk has an absorbing power similar to lime, but in a less degree on the putrid substance of oil; it does not, however, combine so strongly with the oil as to resist separation in the same manner, and is therefore very proper to be conjoined either with lixiviate salts or lime, as it renders a less quantity of either sufficient, and indeed contributes to the separation of the oil from them.

Magnesia alba, or the alkaline earth which is the basis of the sal catharticus, and the singular earth which is the basis of alum, both have an edulcorating power on fetid oils, but, like lime, have too strong an attraction for them to be separated so as to admit of the reduction of the oil from the concreted state to which they reduce it; and therefore, as they are not superior in efficacy to lime and chalk, but much dearer or more difficult to be obtained, they may be rejected from the number of ingredients that are proper for the purifying of oils, with a view to commercial advantages.

Sea-salt has an antiseptic power on the mixed solid parts of animals; but used alone, or dissolved in water, it does not appear to lessen the putrid fetor of oils, but, on the contrary, rather increases it. If after their commixture with it they are subjected to heat, it rather depraves than improves the oils; but though, by its own immediate action on them, it conduces so little to the edulcoration of oils, yet it is a medium for the separation of water and the alkaline substances requisite to be employed to that end. It is of great utility in the edulcorative processes; for when alkaline salts or earths combine with the water necessary to their action on the oils,

or themselves form coagulums or concretions with it, a solution of salt will loosen the bond, and dissolve the close union; so that the oil being separated, will float on the aqueous fluid, while the earth, if any be in the mixture, will be precipitated and sink close together to the bottom of the containing vessel.

Sal catharticus, glauber salt, nitrum vitriolatum, tartar, and other neutral salts, though they counteract putrefaction in the mixed or solid parts of animals, seem to have little effect on oils with respect to their edulcoration, and cannot therefore be ranked amongst the substances proper to be used for that purpose.

Lead, reduced to the state of an oxide, either in the form of minium or litharge, has a strong edulcorative power on fetid oils, and is indeed applied to that end, with respect to one kind of vegetable oil, for a very bad purpose, considering its malignant qualities on the human body.

In the case of train oil, which will scarcely ever be considered among the esculent kinds in this country, the same objection against its use would not lie; and employed either with or without heat, it is a powerful absorbent both of the putrid and empyreumatic parts that occasion the fetor.

As, however, there may be some prejudice against its use even in any way, and as it is not absolutely necessary, it has been refused a place among the ingredients of the processes recommended.

The ochrous earth of iron, commonly called red ochre, has an absorbing power on the putrid parts of oil, but combines so strongly, that the separation is tedious even with the addition of brine: if, nevertheless, it is added when chalk and lime have been some time commixed with the oil, as in process the first, it will promote the edulcorative intention, and will subside along with them; and, as it has some advantage without increasing the expense, unless in the most inconsiderable degree, its use may be expediently admitted in that process.

Essential and etherial oils are applicable to the prevention of putrefaction in the mixed and solid parts of vegetables, but are not so to the edulcoration of fetid oils; and if they had the desired effect, they would not, on account of their price, answer their commercial end, unless the due effect was produced by adding them to the oils in a very small quantity.

The same holds good of spirits of wine as of essential and etherial oils, both with respect to their efficacy and the expense.

Water has an edulcorative action on fetid oils, by carrying off the most putrid parts of the gelatinous fluid or bile, in which, as was above explained, the principal fetor resides, if the quantity added be large, and an intimate commixture be made of them by stirring them together for a considerable time: this only partially removing those heterogeneous putrescent substances, the remaining part soon acquires the same state, and the oil again grows fetid, though not to the same degree as before.

Water is, however, a necessary medium for the action of salts, and the separation of alkaline earths and oxides of metals, when they are employed for the edulcoration of oils, as will appear from a consideration of the proposed processes.

Air edulcorates oil by carrying off the most putrid parts, which are necessarily extremely volatile. It may be made to act on them either by simple exposure of them to it with a large extent of surface, or by forcing it through them by means of ventilators, as has been practised by some dealers; but it appears to be now neglected on account of their finding the improvement of oils by it not adequate to the trouble, as the gelatinous matter and bile, not reduced to a certain degree of putrefaction, being left behind, putrefy again to nearly the same degree as before.

It appears from these several observations, that the cheapest ingredients which can be used for the edulcoration of train-oils, are lime and chalk, which may, with the addition of a proper quantity of solution of sea-salt or brine, be made to procure a separation of them from the oils, according to process the first, so as to answer for some purposes; that the lixiviate salt is the most powerful purifier of oils, and with the assistance of chalk and brine, will without heat, according to process the second, effect a very considerable degree of edulcoration; and that lixiviate salt, used with heat, with the addition of lime and chalk, to save a part of the quantity which would otherwise be necessary, and of brine to procure a quick separation, will perform an edulcoration sufficient for all commercial purposes, according to process the third; but that oxide of lead and the ochrous earth of iron may, perhaps, be applied in some cases to advantage, where the oil is not designed for esculent use.

PROCESS THE FIRST.

For purifying Fish-oil in a moderate Degree, and at a very little Expense.

Take an ounce of chalk in powder, and half an ounce of lime slaked by exposure to the air; put them into a gallon of stinking oil, and having mixed them well together by stirring, add half a pint of water, and mix that also with them by the same means. When they have stood an hour or two, repeat the stirring, and continue the same treatment at convenient intervals for two or three days; after which superadd a pint and a half of water in which an ounce of salt is dissolved, and mix them with the other ingredients, repeating the stirring, as before, for a day or two. Let the whole then stand at rest, and the water will sink below the oil, and the chalk subside in it to the bottom of the vessel. The oil will become clear, be of a lighter colour, and have considerably less smell, but will not be purified in a manner equal to what is effected by the other processes below given; though as this is done with the expense of only one ounce of salt, it may be practised advantageously for many purposes, especially as a preparation for the next method, the operation of which will be thereby facilitated.

PROCESS THE SECOND.

To purify Fish-oil to a great Degree, without heat.

Take a gallon of crude stinking oil, or rather such as has been prepared as above-mentioned, and add to it an ounce of powdered chalk; stir them well together several times, as in the preceding process, and after they have been mixed some hours, or a whole day, add an ounce of pearl-ashes dissolved in four ounces of water, and repeat the stirring as before. After they have been so treated for some hours, put in a pint of water in which two ounces of salt are dissolved, and proceed as before: the oil and brine will separate on standing some days, and the oil will be greatly improved both in smell and colour. Where a greater purity is required, the quantity of pearl-ashes must be increased, and the time before the addition of the salt and water prolonged.

If the same operation is repeated several times, diminishing each time the quantity of ingredients one-half, the oil may be brought to a very light colour, and rendered equally sweet in smell with the common spermaceti oil.

By this process the cod-oil may be made to burn; and, when it is so putrid as not to be fit for any use, either alone or mixed, it may be so corrected by the first part of the process as to be equal to that commonly sold; but where this process is practised in the case of such putrid oil, use half an ounce of chalk and half an ounce of lime.

PROCESS THE THIRD.

To purify Fish-Oil with the Assistance of Heat, where the greatest purity is required, and particularly for the Woollen Manufacture.

Take a gallon of crude stinking oil, and mix with it a quarter of an ounce of powdered chalk, a quarter of an ounce of lime slaked in the air, and half a pint of water; stir them together, and, when they have stood some hours, add a pint of water and two ounces of pearl-ashes, and place them over a fire that will just keep them simmering, till the oil appears of a light amber colour, and has lost all smell, except a hot, greasy, soap-like scent. Then superadd half a pint of water in which an ounce of salt has been dissolved; and having boiled them half an hour, pour them into a proper vessel, and let them stand till the separation of the oil, water, and lime be made, as in the preceding process. Where this operation is performed to prepare oil for the woollen manufacture, the salt may be omitted; but the separation of the lime from the oil will be slower, and a longer boiling will be necessary.

If the oil be required yet more pure, treat it, after it is separated from the water, &c. according to the second process, with an ounce of chalk, a quarter of an ounce of pearl-ashes, and half an ounce of salt.

OBSERVATIONS ON PROCESS THE FIRST.

1. This process may be performed on any kind of fish or seal oil that is putrid and stinking, and will improve it in smell, and generally render the colour lighter, if previously dark and brown; it will also conduce to render these oils fitter for burning, which are, in their crude state, faulty in that point; but it will not meliorate them to the full degree they admit of

even without heat, and should therefore be practised when only a moderate improvement is required.

2. When the oil is taken off from the dregs and brine, the dregs which swim on the brine should be taken off it also, and put into another vessel of a deep form; and on standing, particularly if fresh water be added and stirred with them, nearly the whole remaining part of the oil will separate from the foulness; or, to save this trouble, the dregs when taken off, may be put to any future quantity of oil that is to be edulcorated by this method, which will answer the same purpose.

OBSERVATIONS ON PROCESS THE THIRD.

1. This is most advantageously performed on train-oil, called vicious whale-oil: and the more putrid and foul it may be, the greater will be the proportionable improvement, especially if there be no mixture of the other kinds of fish-oils, particularly the seal, which do not admit of being edulcorated perfectly by means of heat, but require other methods: but when the vicious oil is pure from admixture of others, however stinking it may be, the bad smell will be removed by this process duly executed, and the brown colour changed to a very light amber; and these qualities will be much more permanent in this than in any crude oil, as it will not, from the degree of purity to which it is brought, be subject to putrefy again under a great length of time, whether it be kept open or in close vessels.

The oil in this state will burn away without leaving the least remains of foulness in the lamp; and, being rendered more fluid than before, will go further, when used in the woollen manufacture, than any other kind, and will be much more easily scoured from the wool.

If, nevertheless, there be any branches of the woollen manufacture which require the use of a more thick and unctuous oil, this may be rendered so by the addition of a proper quantity of tallow or fat, of which a certain proportion will perfectly incorporate with the oil, the fluidity and transparency being still preserved, as well as all the other qualities that render it suitable to the intended purpose. This may be most beneficially done by adding a proper quantity of the refuse grease of families, commonly called kitchen stuff, which being put to the oil, when moderately heated, will immediately dissolve in it, and let fall also its impurities or foulness to the

bottom of the vessel, and render the purified admixture a considerable saving to the manufacturers.

2. The different qualities and dispositions of different parcels of vicious oil, with respect to edulcoration, render various proportions necessary of the ingredients to be used. The quantities stated in the above process are the least which will effect the end in general, and frequently greater will be required; but this may always be first tried; and if it be found, after six or eight hours simmering of the mixture, that no gradual improvement is making in the smell and colour. but that the oil continues the same in those particulars, and remains also mixed with the chalk and lime, and in a thick turbid state, a fourth or third part of the first quantity of pearl-ashes should be added, and the simmering continued till the oil be perfect. As the quantity of the water is lessened by the evaporation, it is necessary to make fresh additions from time to time, that there may be always nearly the original proportion.

3. If it be inconvenient to give the whole time of boiling at once, the fire may be suffered to go out, and be rekindled at any distance of time; and if, in such a case, a small proportion of pearl-ashes dissolved in water be added, and the mixture several times stirred betwixt the times of boiling, it will facilitate the operation. The time of boiling may be also much shortened, if the chalk, lime, and pearl-ashes, be added for some days before, and the mixture frequently stirred.

PROCESS THE FOURTH;

Which may be practised alone instead of Process the First, as it will edulcorate and purify Fish-Oil to a considerable degree, so as to answer most purposes, and for Process the Third, when the whole is performed.

Take a gallon of crude stinking oil, and put to it a pint of water poured off from two ounces of lime slaked in the air; let them stand together, and stir them up several times for the first twenty-four hours; then let them stand a day, and the lime-water will sink below the oil, which must be carefully separated from them. Take this oil, if not sufficiently purified for your purpose, and treat it as directed in Process the Third, diminishing the quantity of pearl-ashes to one ounce, and omitting the lime and chalk.*

* The dregs remaining after the sundry processes, form excellent manure.

To this article we may add the following method of purifying lamp oil by filtration, recently invented by John Baker, of London, and rewarded by the Society for the Encouragement of Arts, &c.

Take a garden flower-pot, glazed within and without, and into the aperture at the bottom of it, press a piece of clean dry sponge, which should be left projecting both on the outside and inside of the vessel. Fill the pot thus prepared with Greenland oil, which will slowly pass through the sponge into a receiver placed below, and is then ready for use. The sponge may in general be used several times, before it is taken out to be thoroughly cleaned; but each time the vessel is filled, it should, as well as the sponge, have the dregs removed from it with a spoon.

By this process, the common crude lamp oil of the shops is so much improved, as to burn like that of spermaceti, and readily sells at an advanced price.

A Machine for Counterbalancing the Ropes used in the deep Shafts of Mines.

Various schemes have at different times been resorted to, for counterbalancing the ropes used in the deep shafts of mines, and maintaining a constant equilibrium among them, One of the best which the Inventor of this machine had observed, was the following: a chain is fastened to the axis of the rope-barrel, which passing over a pulley, descends into a pit, and is there fastened to the end of a very heavy chain. When the ropes are in equilibrio, the large chain is at the bottom of the pit; but as the difference of their weights increases, the small chain, winding upon the axis of the rope-barrel, lifts up the large one from the bottom of the pit, till it is suspended at full length, at which time one corf has ascended to the top of the shaft. One disadvantage attending this counterbalance, is the depth of the pit for the chain to descend into. This depth, at a machine upon a colliery belonging to Sir Henry Tempest Vane, Bart. was found, upon being measured, to be 14 fathoms, from the axis of the pulley to the bottom; the depth of the shaft being 88½ fathoms.

The owners of Heaton colliery, near Newcastle-upon-Tyne, expended nearly £200, in attempting to sink a pit for the counterbalance chain, but could not get deeper than 3½

fathoms on account of water; they therefore fixed the pulley five fathoms from the top of the pit, making the whole length of space for the chain to move in, 8½ fathoms. They have lined the pit near the bottom with metal plates, to prevent the chain from wearing away the sides; but there can be no doubt that the chain will suffer much by friction.

The counterbalance which the Inventor erected at a coal-pit in Harraton colliery, situated about two miles from Chester-le-street, and belonging to the trustees of the late W. H. Lambton, is still used. The depth of the pit for the counterbalance is five fathoms, measured from the axis of the pulley to the bottom. The weight suspended at the end of the chain is 30½ hundred weight; the diameter of the wheel 15½ feet; depth of the shaft 76½ fathoms; and the weight of 76½ fathoms of rope, 5½ hundred weight.

Another disadvantage attending the counterbalance first described, is, that it does not regularly take off the weight of the heavier rope, which will appear by considering that, immediately after the corves have passed each other in the shaft, and the difference of the weights of the ropes is very small, the lesser chain is acting very powerfully upon the axis, which is of an equal diameter in each part whereon the chain winds. According to the new plan, indeed, there is an irregularity occasioned by the length of the chain, but it is very trifling. One inconvenience which may possibly attend the new counterbalance is, that as the engine-men, through inattention, sometimes draw a corf over the pulley above the shaft, the weight at the end of the chain may be drawn to high, and some part of the machinery broken; but during a year and a quarter's constant use of it, the engine-man, though he has sometimes drawn a corf over the pulley, has always been able to stop the machine before any accident happened. It would considerably diminish the friction, to fix the large wheel nearly in a horizontal position, with bevel-teeth, so that its weight might rest almost entirely on one end of the axis.

In plate XXXII, FFF are the different parts of the framing of the counterbalance. A steam-engine is supposed to turn the barrel A, by means of a crank at the end D.

E is a fly-wheel. RR are the ropes which descend into the mine. When the engine is put in motion, the barrel A revolves, and by means of a pinion on the end of its axis, turns the wheel G; and the chain C, with a weight W at the end, winds upon one of the curves KK, which are formed of pieces of timber strongly fastened to the arms of the wheel G, and on

the circumference of which grooves are cut to prevent the chain from slipping off.

The teeth of the wheel and pinion are of cast iron. A pit must be dug for the weight W to descend into, but it need only be of a very small depth; whereas for the counterbalances heretofore generally used, a pit of considerable depth is necessary, in the sinking of which, when there has been much water, very large sums have been expended.

When the wheel G has revolved so far that the chain makes a right angle with the arm V, it then acts with its greatest power, and the difference of the weights of the ropes is the greatest.

The curves KK were attempted to be drawn of such a form, that as the wheel G revolved, a perpendicular let fall from its centre, upon the line of direction of the chain, might uniformly increase; but according to the method in which the chain is applied, this could not be done with perfect exactness.

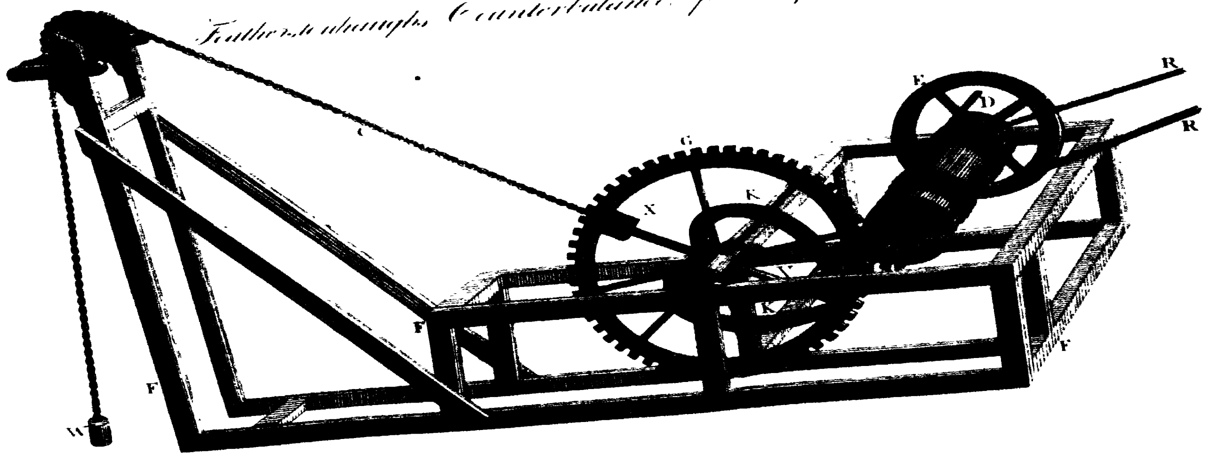
X is a weight to balance the curved pieces of timber on the opposite side of the wheel.

Where there are several strata of coal in one pit, if a counterbalance be calculated for the deepest, it will answer for the rest without alteration. Where the depth is very great, two counterbalances may easily be applied; or the power of this counterbalance may be increased, by making the spiral-shaped pieces of times extend beyond the circumference of the wheel.

Machine for the use of Painters and Glaziers.

Those improvements which are so simple when explained, that they appear to be the most easily made, are often found to be the identical improvements which remain the longest unknown. Hence it frequently happens that a machine is within a hair's breadth of being as appropriate and perfect as art can render it, although it is, and has been for ages, distinguished by defects of the most important kind. When a man of ingenuity steps forward, and removes these defects, the illiberal and the ignorant are apt to say that he has accomplished very little, because they view the praise of another as the detraction of themselves, and consider the similarity in the appearance of the new and old machines, more than the difference of their defects or total advantages. The invention to be described in the present article, fully verifies these remarks. Perhaps no class of men place themselves

Featherstonhaugh's Counterbalance for Ropes in deep Mines.



in a situation of such precarious safety, as painters and glaziers in using their ordinary machine for supporting themselves at the outside of a window; yet merely by the addition of a screw, instead of the two upright irons which are put through the holes, made into the top plank of the old machine, all the security that the stability of their support can give is effectually obtained. The following is a description of the new machine.

Fig. 6, plate XXVI; the part *a* is similar to that of the machine used by glaziers generally, and is placed on the outside of the window. *b* is an additional moving piece, which presses against the inside of the window-frame, and is brought nearer to, or removed further from it, by means of the screw *c*, and its handle *d*.

Fig. 7, shows the lower part of a window, and the manner in which the moving-piece *b*, including the box of the screw, acts against the inside of the window-frame.

Fig. 8, shows a cross-bar introduced in place of the moving-piece last mentioned, which bar extends from one window-side to the other, and explains how the machine may be used, where any injury might arise from screwing the moving-piece in the centre of the recess of the window.

There are two blocks, marked *f f*, in fig. 6, which may be occasionally put in, or taken out, according as the stone-work under the window may require.

Bookbinder's Cutting Press with one Screw.

The common bookbinder's cutting press which has been immemorially in use, consists of two strong wooden cheeks, which are brought near each other, or set further apart, by means of two wooden screws, one of which passes through them at each end. The disadvantage of this press is, that the cheeks do not close or open in a parallel direction, unless both screws be turned at once, which is very seldom convenient to the workman, because in using the press, one hand is almost constantly employed in taking out or putting in the paper or book upon which he operates. He is therefore obliged, in using this machine, to close the press by applying one hand alternately to the head of each screw, and then to fasten them by a loose iron lever, which in like manner is applied first to one, and then to the other.

The improvement upon the form of the press above described, consists chiefly in making one iron screw serve the

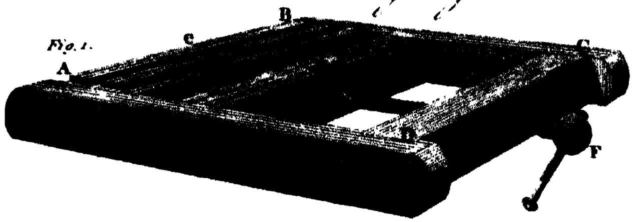
purpose of the two wooden ones. To effect this, a stout rectangular frame, ABCD, fig. 1, plate XXXIII, serves as the body of the press. The sides AB, answer the same purpose as the left-hand cheek in the common press, and B has longitudinal ribs, *cc*, nailed upon it, for one side of the plough which cuts the paper to slide between. On the inside of this frame are two rectangular grooves, one of which is in the side AD, and the other in the opposite side BC. These grooves admit the projecting notches from the middle of the extremity of the sliding cheek E, which is thus adapted to receive a motion for traversing the interior space from the side AB to the side DC. F is an iron screw, the box of which is fastened in the centre of the side DC of the frame. The extremity of this screw works in a socket, fastened to the sliding cheek E; the socket allows the screw to turn round, but prevents it being separated from the cheek in turning back. The socket should not be very tightly fitted, because the workman occasionally requires the press to be more open at one end than the other, and further to promote this convenience, there should be a small degree of liberty in the sliding part of the cheek, to prevent its sticking in the frame when not exactly parallel with the side AB. The sliding cheek E, should in other respects fit its grooves so well, that it can neither be raised above nor sunk below the level of the frame.

An iron screw, working in a brass box, has so much less friction than a wooden one, and is so much more powerful from the greater fineness of the threads, that a lever of 12 or 14 inches in length will in the new press produce a much stronger compression than the lever applied to the common press, although the latter is about twice the length of the former. It may be supposed that time will be lost, in turning the iron screw, because it will not advance so far at each revolution as the wooden one; but this supposed disadvantage vanishes in a comparative trial, from the great facility with which the iron screw is turned by its lever; and when there is no pressure upon the screw, the acting part of the lever may be reduced by keeping the middle instead of the end of it, in the head of the screw, in order that the hand in turning it round may have less space to pass through.

A common binder's press, with the box which receives the shavings, generally takes up a space equal to a cube, of which a side contains nine square feet. This is a space which cannot always be spared by those to whom otherwise a cutting press, for occasional use, would be very desirable. The new press, when

Hardie's Bookbinder's Cutting Press.

Fig. 1.



Pakenham's Ship's Rudder.

Fig. 2.

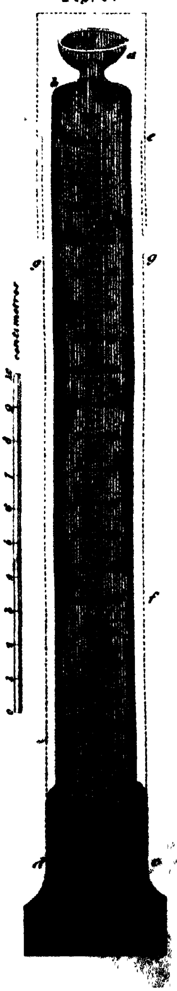


Fig. 3.

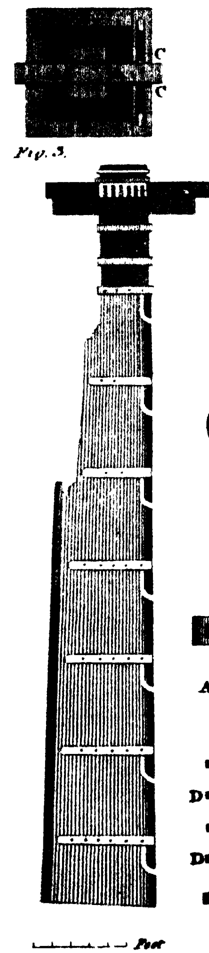
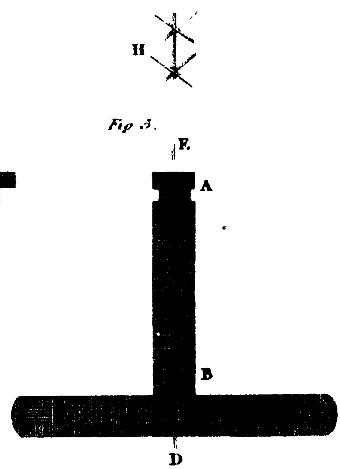
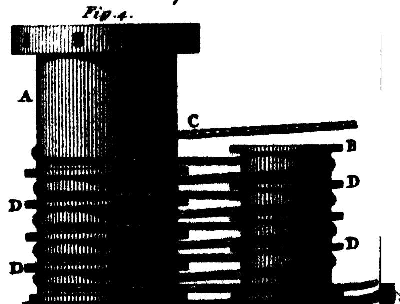


Fig. 3.



Boswell's Capstan.

Fig. 4.



the frame is made of wood, affords no advantage of moment over the old one, in point of compactness; but if it be altogether made of iron, it will cut as large a size of paper, and take in as many books as the wooden one, in a compass remarkably smaller. An iron cutting press 24 inches long, and 15 inches broad, will cut a size of paper within four inches of its own entire length; and take in a parcel of books or paper within six inches of its own breadth.

Cast iron will be the most proper for this machine, and the pattern required is so simple, that the expense of it will be but little. It is possible to cast with the frame the grooves required for the sliding cheek; but when this is attempted, they generally turn out rough and untrue, and the difficulty of finishing them afterwards occasions a great expense. It is better therefore to form the grooves by screwing to the lower part of the inside face of the ends of the frame, separate pieces of iron, previously made smooth and true, to complete the groove by forming its lower side. The upper side of the groove should be cast in the same piece with the whole frame.

Substitute for a Crank in communicating Motion to a Foot Lathe.

The difference between the method now recommended, and the common crank, as usually employed for this purpose, is, first, that in order to obtain a proper motion of the crank with full power, it must be placed in one point of its revolution, which requires time and dexterity; whereas in the mode now proposed, the machine is always ready for the stroke, and the revolution immediately takes place on putting the foot on the treadle.

Secondly, in the common crank the power acts only in a small part of the revolution, and the full power is exerted only at one point; but in the present contrivance, the power is constantly exerted at that point where it can act with the greatest effect; and this will prove particularly useful in the finer and more curious kind of work, for which the crank cannot be made to go slow enough.

In figs. 3 and 4, plate XXXI, AAAA represent the [illegible] which incloses the wheels and the whole machinery. BB, the floor or platform on which the frame is fixed.

Ridley's substitute for a crank to give motion to a foot lathe.

C, the treadle, moveable at the end of the platform at S, between two centres.

D, a spring placed under the treadle, in order to throw the treadle up, and keep it always ready for the foot to set to work.

EE, the large wheel for the band, to which the mandrel, &c. is to be attached in the usual way.

Fig. 4, F is an iron spindle, on which the great wheel E, and the ratchet-wheel G. fig. 5, is fixed.

The ratchet-wheel is inclosed in a brass box HHH, with holes in the centre, on each side, and small projections, forming shoulders that work on the cylindrical parts at the centre of the ratchet-wheel G, through which the spindle F goes.

III, a piece of brass, sliding on the surface of the rim of the box H, to govern the click *i*, which is pinned in the inside of the brass box, and is worked by three straps going round the box H.

The double strap, KKKK, is fastened to the slider I, and brought over the rim of the box H, and fastened to the lower part of the steel bar L, which is jointed to the end of the treadle at T. By putting the foot on the treadle, and pressing it down, the click *i* takes hold of the ratchet-wheel G, by which the power is obtained. To dislodge the click, and bring the brass box back for another stroke, there is a single strap MM, fixed to the other end of the slider I, and brought under the rim of the brass box H, and made fast to the top of the steel bar L. When the foot is up, the great wheel E is at liberty to go backward or forward, for the convenience of running back a screw-mandrel, or taking off a chuck. For disengaging the click, two springs, N, lined with cork at the ends, are to be placed one at each side of the brass box, and pressing gently against it.

O, a screw which goes through the springs N, and regulates the degree of their pressure on the brass box; these springs are fixed on a thin piece of steel P, rising from the bottom, to which is soldered a piece of brass, Q, having a screw passing through it at R, by which the upright steel bar is regulated.

V, a small piece of cork, fixed on the platform, to prevent the treadle from making any noise in coming down.

An improved Letter File.

There are few persons engaged in business who have not felt the inconvenience of taking letters, &c. from a common file, but this mode of arranging papers has been considered so simple that the improvement of it appeared hopeless. We shall, however, presently see that files may be so constructed, that a voucher may be speedily disengaged from any part of them, without cutting, or otherwise defacing it, and without taking off the papers above it. The purpose is effected, by making the wire pass through a cylinder, and fastening it by a screw at the bottom. Thus the tube *a*, fig. 6, plate XXXI, has a convex circular plate soldered to its lower end, to keep the papers from slipping off the file, and has attached to its under side a piece of metal *b*, fig. 8, with a screwed hole in it, to receive a screw on the end of the wire *c*, fig. 6, the other end of the wire being formed into a hook sharpened at its point, to receive the papers as usual; when any paper is required to be taken off the file, the uppermost papers are to be slipped up towards the top of the wire *c*, which must be unscrewed, and with the papers upon it, removed, as shown in fig. 9; the paper wanted may then be taken away, the wire replaced again into its tube *a*, and screwed fast, and the other papers drawn down the tube as before. The upper extremity of the tube *a* should be made conical, and its edges sharp, the better to suffer the papers to pass over it. A section of the tube and socket-screw *b*, at the bottom of it, is shown separately at fig. 8. The papers are shown in fig. 6, in the situation they are commonly placed upon the cylinder, with the wire within the cylinder.

Improved Spinning Wheel.

The improvement consists in the method of causing the bobbin to move backward and forward, which is effected by extending the axis of the great wheel through the pillar next the spinner, and forming it into a pinion of one leaf, A, plate XXXIV, which takes into a wheel B, seven inches in diameter and containing 97 teeth; so that ninety-seven revolutions of the

great wheel cause one of the lesser wheel. On this lesser wheel is fixed a ring of wire *ccc*, which being supported on six legs, stands obliquely to the wheel itself, touching it at one part, and projecting nearly three-quarters of an inch at the opposite one. Near the side of this wheel is an upright lever C, about fifteen inches long, moving on a centre, three inches from its lower extremity, and connected at the top to a sliding bar D, from which rises an upright piece of brass E, which working in the notch of a pulley, drives the bobbin F backward and forward, according as the oblique wire forces a pin G, in or out, as the wheel moves round. To regulate and assist the alternate motion, a weight H, hangs by a line to the sliding bar, and, passing over a pulley I, rises and falls as the bobbin advances or recedes, and tends constantly to keep the pin in contact with the wire.

It is evident, from this description, that one staple only is wanted to the flyer, which being placed near the extremity K, the thread passing through it is, by the motion of the bobbin, laid regularly on.

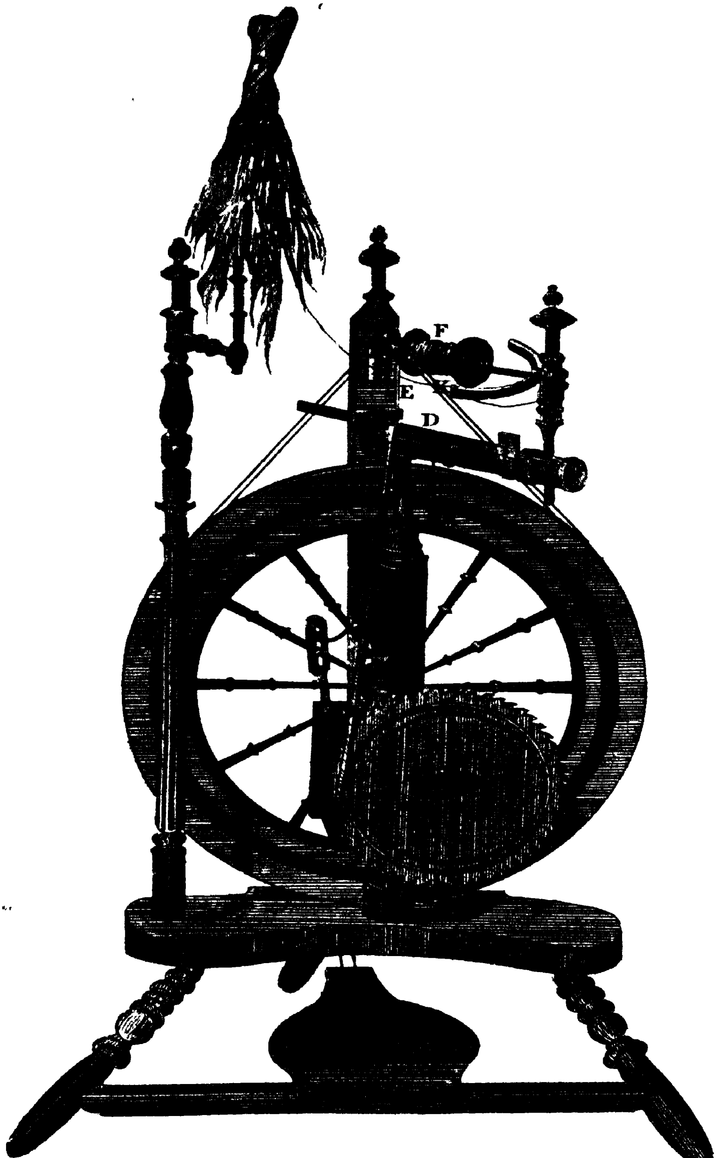
The old wheels, at the best, always wind the thread in ridges, and if a thread breaks, it is in general very difficult to find it again; but by the motion of the bobbin here described, the threads are wound across one another, by which means the end can never be lost. With respect to time, it is calculated that the improvement will save about two hours per day.

The Inventor of the above improved spinning-wheel, after a considerable experience of its action, still found that by some alterations it might be rendered more complete. The following considerations exhibit his views, and the nature of these further improvements:

1st. Besides the disagreeable catch which the pinion of one leaf gave at every revolution of the wheel, the bobbin moved only by sudden jerks, and did not lay the thread on so even as might be wished: to remedy this, he adopted the motion of an endless screw, working a toothed wheel with a heart-shaped piece of brass fixed upon it.

2ndly. As the spinner must be always perfectly at liberty to hold the thread at pleasure, and not to let it in until it is sufficiently twisted, he observed, that as the bobbin moved upon a square, the holding of the thread so affected it, that, particularly when the bobbin began to be filled, and consequently the purchase to be further from the centre, it became quite stiff upon the square and incapable of moving, notwithstanding the action of the weight; and afterwards, when

Antis's Spinning Wheel.



J. Smith, Liverpool, Octr 1815.

the thread was left at liberty, it would jump at once half an inch or more; and this would invariably have been the case with every other contrivance of the kind which might be substituted; as, for instance, a cylinder with a rib, &c. &c. except the weight had been much heavier, which would have occasioned a greater friction on the machine.

3dly. Besides what has been observed above, it is well known that in all spinning-wheels upon the old plan, as well as in the improved one described above, there was no other way to increase the friction of the bobbin, and make it take in more or less in proportion to the quantity of thread upon it, than by stretching or tightening the double cord; and this could never be done but at the expense of making the wheel go heavier and heavier, so that it became quite troublesome when the bobbin was nearly filled. The same effect followed in wheels that were made with a single cord, having another added to occasion a pressure on the neck of the bobbin, whereby the friction was increased or diminished; because the same degree of pressure it made upon the bobbin, was also made upon the spindle, or upon a stud upon which the bobbin turned, as in the ladies' common spinning-wheels. As this latter method could not be used with a sliding bobbin, it became necessary to contrive a new mode to make the one quite independent of the other, so that the bobbin might move to and fro with the greatest freedom, and there might be a means of increasing the friction without any effect on the velocity of the whole machine. After various trials, the Inventor adopted the plan of using a single cord, which has only to turn the flyer, therefore needs no screw to tighten it; for should it ever become too slack to do its duty, it may easily be tied or stitched a little shorter.

In order to regulate the friction on the bobbin, there is a neck of brass or steel fastened to one end of it, of which a vice or pincers fixed to the sliding bar takes hold: this vice must be made either of two elastic springs with wooden tops, or entirely of wood, and bushed with leather; but if of wood only, then a spring must be made under the shoulder of the screw to answer the same purpose. By tightening this screw more or less, the friction may be regulated to the greatest nicety, provided the springs are of a strength rightly proportioned to their functions. It will readily appear that all this may be done without the least effect on the velocity of the whole machine, as nothing is added to the general friction so as to obstruct it; such a wheel will therefore be found to run

much more freely than one with a double cord; and this must be considered a great advantage to a spinner who is obliged to spin the whole day for a livelihood.

A wheel with these additional improvements, is as much superior to the former one, as that wheel is to the common spinning-wheel.

On the Alkalies of Commerce, and the means of ascertaining their Commercial Value by an Instrument called an Alkali-metre.

Soda and potash are never met with in a state of purity in commerce. Of these alkalies, the least impure are those which contain merely carbonic acid and water; next to which are those which contain earths, carbonate of lime, sulphur, charcoal, and particularly the alkaline muriates and sulphates, of which a fraudulent mixture is sometimes made, extremely prejudicial to manufactures in which these alkalies are used.

For a long time it has been a great desideratum to discover a prompt and easy process for trying potash, soda, natron, and the other alkalies, which might be both within the reach of buyers, and certain in its results. The areometer, so convenient in the spirit trade, and even for trying the sulphuretic, nitric, and muriatic acids, is insufficient in this respect. It has been successively suggested to employ various acids, and some of their combinations with precipitable bases. The sulphuric acid, pure and uncombined, the Author considers the most suitable for this purpose; its price is low, it can every-where be procured, and can be brought to the same state of concentration. He found the most expeditious process for judging comparatively of the value of various specimens of alkali, to consist in ascertaining how many hundredth parts of their weight they require of sulphuric acid for their saturation.

DESCRIPTION OF THE ALKALI-METRE.

The alkali-metre is a glass tube eight or nine inches long, and seven or eight lines in diameter. It is represented in plate

XXXIII. fig. 2. At one end it is closed, the other terminates in a small funnel, with a beak *a*, connected with the tube by a neck, the aperture of which is about two lines and a half in diameter. Upon the shoulder which supports this neck is a hole *b*, for letting the air out and in. Fig. 2, is a vertical section of this instrument mounted upon a stand *c d*, in which it is solidly fixed with mastic, by means of a kind of hook (shown at *c d*) left for this purpose at the lower extremity of the tube. In order to facilitate the carriage of the instrument, it is furnished with a tin case, without a bottom, having a lid *e*; the other part *f*, being, like the former, indicated by dotted lines, is a tube open at both ends, and upon which, in order to fasten the lid, there must be a projection *g g*.

The alkali-metre ought to contain easily 76 demi-grammes, because each division, or degree, which we trace afterwards upon the instrument, represents a demi-gramme of this liquor, which it is extremely important to proportion accurately as follows:

ALKALI-METRIC LIQUOR.

Take concentrated sulphuric acid, or oil of vitriol of commerce, at 66 degrees of Baumé's areometer; afterwards put in equilibrium, in a good balance, a vessel of porcelain or glass, and pour into it a given weight of the above acid, say a hectogramme; add very gradually, on account of the caloric which is liberated, nine hectogrammes of pure water; stir it well with a glass rod, and then put it into a glass bottle, which must be corked up, that no alteration, either by dust or evaporation, may take place.

GRADUATION OF THE ALKALI-METRE.

The alkali-metre is graduated by given weights of this liquor in the following manner: Place the instrument in perfect equilibrium in a balance, and introduce into it, very exactly, two grammes of the test liquor; place the tube afterwards in a vertical position, and mark the level by a small scratch with a diamond; pour in once more, and all at one time, 36 grammes of the liquor, and mark this level also by a scratch: after this empty the instrument, and draw a mark on the other four vertical parallel lines; and forming three

spaces of about one line between each, mark on the two extremities two small transverse lines, making right angles with the other four; then write 0 in the upper part, and 72 in the lower; pour liquor into the tube afterwards, up to the point marked 72; put the instrument once more in equilibrium, and introduce one after the other 71 demi-grammes of the test liquor, taking care to mark, each time, one point in the middle scale: this being accomplished, trace regularly, by four and four points, lines across the three scales; then trace, in the same manner, upon all the other points, lines through the middle scale only: engrave, after this, on one side, and opposite to each fourth division, the numbers 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64, 68, and 72: as shown by the figure. The marks are easily made with a glazier's diamond.

ALKALI-METRICAL REQUISITES.

Besides the alkali-metre and the test liquor, the following articles must be procured:

1. Syrup of violets.

2. A small balance; those for weighing gold coins will answer; we may, however, employ smaller.

3. Weights of 2 drachms, 44 grains, and two-thirds of a grain.

4. A measure of a demi-decilitre, or rather, according to the old system, the small measure answering to the sixteenth of a Paris pint, (those which have no lids are preferable;) this small vessel is intended to give any two measures of water, and its capacity is not of very great consequence; any other vessel of nearly the same capacity will answer.

5. Common drinking-glasses; those whose edges are turned outwards should be preferred: if common glasses only are used, before decanting a portion of the liquor into them, as above-described, we must give a slight coating of oil, fat, or grease, to part of their orifice, which will prevent an irregular flowing down the outer sides.

6. Small slips of wood, or matches from which the sulphured ends have been taken off.

7. A bottle of water and an earthen plate.

8. Lastly, for soda, hard American potash, and natron, there must be a metal pestle and mortar, of about six inches in its greatest diameter.

The whole being arranged, any given alkali may easily be tried; we shall take potash as an example.

ALKALI-METRICAL TRIALS OF POTASH.

Weigh exactly one decagramme, or 2 drachms 44⅔ grains of potash; put it into a glass, and pour upon it about four-fifths of a demi-decilitre of water; facilitate the solution of the potash by stirring it with a small slip of wood, three or four times in an hour and a half, a minute at each time. When you think the solution is effected, pour it into a small tin measure, which you then fill up with water; pour it back again into the glass, into which you must still pour a measure full of pure water: stir this new mixture also three or four times within half an hour, in order to facilitate the precipitation of a slight sediment, which soon falls down. This sediment being completely formed, slope the glass with caution, in order to fill with clear liquor the small measure; and after emptying this last into another large glass, place round the edges of a plate, drops of sirup of violets; pour also into the alkali-metre test-liquor, until the line marks 0: take it afterwards with the left hand, inclining it upon the glass which contains the moiety of the clean alkaline solution; the acid liquor will fall into it by hasty drops, or in a very small thread, which may be moderated at pleasure, by retarding the entrance of the air at the lateral hole or vent, upon which must be placed the end of the finger; at the same time, with a small stick or match, assist the mixture, and facilitate the developement of the carbonic acid, which is manifested by effervescence. When the alkali-metre is emptied to about the line marked 40, try if the saturation approaches, by drawing the small stick from the mixture, and resting it upon one of the drops of sirup of violets, which should become green, if the potash is not of a very inferior quality. If, on the contrary, the violet colour is not altered, or, what would be worse, if it be changed into red, there would be in the first case an indication of saturation, and in the second, a proof of supersaturation. But this is not the case with good potash: at that line, the liquor tried can alter the sirup of violets into green only; or cause to return to the violet, and even to the green, the drops which had been changed into red at the time of a former trial; we must, therefore, in general add more acid, which occasions a new effervescence; this addition must be always made with caution, and

we must touch every time a drop of sirup of violets, in order to stop. When at last the latter assumes a red hue, then after having restored the alkali-metre to a perpendicular position, in order to see at what line the testing liquor stops, you must reckon one degree less, in order to compensate the excess of saturation. The mean term of potash is 55: this implies that it requires for its saturation fifty-five hundredths of its weight of sulphuric acid.

INVARIABILITY AND FACILITY OF THE ALKALI-METRICAL PROOFS.

Let us now examine the operation we have described. We have, on the one hand, put into solution one decagramme of potash, nevertheless we have only taken definitively the moiety of this solution; thus it is reduced to 100 half-tenths of the grammes: on the other hand, we have put into the alkali-metre 38 grammes of a liquor composed of one part in weight of sulphuric acid, and of nine similar parts of water: the 76 demi-grammes of the test liquor, therefore, contain 76 demi-tenths of grammes of effective acid, and, if it required 55 demi-grammes of this liquor, in order to saturate the proved potash, we are evidently well founded in saying that this alkali has absorbed a quantity of sulphuric acid equal to 55 hundredths of its weight.

Each trial, however, is made without calculation; a single weight is sufficient, and the instrument finishes the rest almost alone.

In some countries from which potash is exported, there are inspectors of this article: but they have not had, until this moment, any method of inspection which could be compared with that described in this memoir.

ALKALI-METRICAL TRIALS OF SODA, NATRON, TARTAR ASHES, TOBACCO ASHES, &c.

It requires but a very slight modification in this process, to apply it to the trial of soda; in place of one decigramme, *i. e.* ten grammes, we must put about ten and a half, or, if we please, three drachms, in a middle-sized metal mortar, and pound them strongly for five minutes, so as to produce a fine powder, of which we must weigh exactly one decigramme, or,

what is very near that quantity, two drachms and forty-four grains and two-thirds of a grain, which we afterwards put into the water, as is said above of potash.

Sicilian ashes, or the ashes of the rocket plant, and other similar alkaline substances, are tried like soda.

Natron, tartar-ashes, tobacco-ashes, &c. also require to be bruised before weighing the ten grammes for the trial.

ORDINARY ALKALI-METRICAL RESULTS.

The various alkaline substances present the alkali-metrical degrees marked in the following table: these marks are the results of several thousand trials, made by the Author during a period of five-and-twenty years.

Substance	Degrees
American pearl-ash; best sort	60° to 63°
American caustic potash in reddish masses; first sort	60 — 63
American pearl-ash; second sort	50 — 55
Caustic potash of America, in grayish masses; second sort	50 — 55
White potash of Russia	52 — 58
White potash of Dantzic	45 — 52
Blue Dantzic potash	45 — 52
Alicant soda	20 — 33
Natron	20 — 33
Soda and natron of inferior qualities	10 — 15

EXTRAORDINARY ALKALI-METRICAL RESULTS.

Great variations are met with in some parts of these articles; in the pearl-ash and potash, for instance, by the fraudulent mixture of various foreign salts, the alkaline part of which, neutralized by the sulphuric and muriatic acids, is of no use to soap-makers, dyers, and bleachers. We meet with variations also in soda by means of the addition of herbs, other than the salsola and the salicornia at the time of incineration; or also in soda produced by the combustion of plants before their maturity; for, according to Chaptal, the latter is almost entirely muriate without alteration. Some potashes contain sulphur and charcoal in solution: the casks and packages of these alkalies are not always of the same quality in their

ifferent points and various pieces. The two extremities of a cask, and its centre towards the bung, have been found to contain good potash: the other parts were of a very inferior quality, or contained nothing else than earth. Some unprincipled people have made a traffic of soda from sea wrack, which they sell in place of Alicant soda, giving it an exterior appearance by means of a process, which it would be useless if not criminal to divulge.

On the other hand, extraordinary degrees in point of strength are sometimes met with, such as pearl-ash at 66°; American potash of the first sort at 72°; and even the potash, marked second sort, at 66°, and, lastly, pieces of natron at 60°. These last had probably been deprived of all water of crystallization.

UTILITY OF A METHOD OF GRADUATION FOR THE ALKALIES OF COMMERCE.

Not only the consumer of the alkalies of commerce has hitherto only had very precarious methods of estimating comparatively the real pecuniary value of what he buys, but also that he is exposed to very troublesome inequalities in the result of his operations, if he employs, as almost always happens, the good and the bad commodities in equal doses. Whether a dyer, for instance, employs soda at 30° or at 15°, he will be equally exposed to fail in his operations and consequently to experience great losses, either from his alkali being weaker or stronger than usual.

On extending these reflections, we see that all the arts which require the consumption of alkalies would be benefitted, if, on the one hand, potash, soda, and natron, were constantly homogeneous in the same cask, and bore a mark indicating their alkaline strength; and if, on the other hand, we could announce in the prices current that such an alkali, of a certain alkali-metrical degree, costs so much the cwt. We may conceive, in fact, what advantage a dealer in this article would have over his neighbours, who could say to his customers,—"I offer you graduated potash, graduated soda, graduated salt of soda, and graduated natron, at such and such prices and alkali-metrical degrees. You have now in your possession an instrument with which you may, without chemical knowledge and without calculations, try, or cause to be tried under your own inspection, one hundred specimens in a day, and thus

verify the qualities I announce to you in my prices current, and which are marked upon my packages.—It cannot be doubted that the merchant who could deal in this manner would obtain a great preference, and ultimately others would be induced to pursue the same course. We shall now proceed to the details of the processes of which he may avail himself.

GRADUATION OF POTASH, SODA, AND NATRON.

Suppose we have 100 casks of potash, containing about 400 kilogrammes each; we may give all of them the same alkaline strength, and may afterwards ascertain it, and point it out in a precise manner.

Each of the casks is to be opened at one end, and the potash it contains is to be emptied upon the ground. We must then break, with a long-handled mallet, all the masses which are larger than a large nut; and the whole must be mixed equally, which may be done in five minutes by two men furnished with wooden shovels. The potash may be afterwards replaced in the casks, arranging the business so that the casks, whether full or not, shall contain the same number of pailfuls or measures. All these casks having been thus opened, their contents broken and mixed up, a common mixture may be once more made of all their contents.

For this purpose, a place being set apart on the floor of the store-room, we must bring, one after another, a pailful of the potash from each barrel alternately; a sufficient number of men being furnished with wooden shovels, the whole mass may be mixed up as exactly as possible. The casks are afterwards filled; and by this means we may ascertain that their contents have an equal degree of alkaline strength, which may be proved by a single trial.

The trial must be done with exactitude, and in the following manner; we must put about two kilogrammes of the general mixture into a mortar, and pound them until no piece remains larger than a grain of wheat. One decigramme must then be weighed exactly, which upon being subjected to the proof by the alkali-metre, will indicate the alkaline strength of the whole potash in the casks.

It is easy to prevent any loss of weight in any of the casks, by care and celerity in the manipulation; during which, in damp seasons, a stove should be placed in the store room; if this precaution is not adopted, there will be an increase of weight.

It will not be difficult to apply these manipulations to soda; this article, must be first broken by means of a piece of iron, then pounded in mortars, or bruised under a vertical mill, the stamper of which is inserted in a wooden axis: the soda in powder must then be passed through a metallic sieve for the convenience of those who use it. As soon as the quantity is procured requisite to fill a given number of casks, we must then proceed to make the general mixture above described, and pursue the usual method, with the peculiar modifications applicable to the trials upon soda.

As to natron, the same method may be adopted as with potash, with this exception, that as the masses are generally larger and harder, they require a little more time and manipulation than potash.

Some people may be apprehensive that the expense of these manipulations would counterbalance the advantages to be derived from them; but, upon trial, it will be found that objections of this nature, from the simplicity of the operations required, have not the weight that may be imagined.

APPLICATION OF THE ALKALI-METRE AS A BERTHOLLI-METRE.

The alkali-metre may be made to answer the purpose of the instrument called a Betholli-metre. The same scale serves for both instruments, with this difference, that the alkalimetrical scale is on the right side, and runs from top to bottom, but the Bertholli-metre is on the left side, and runs from bottom to top. The engraving clearly shows this two-fold arrangement. The Bertholli-metre by this means is simplified, but it has not the same precision as the original. It cannot, however, fail to be very useful to bleachers after the Berthollian process.

CONSTANT PROPORTIONS OF CARBONIC ACID IN THE SALT, WITH EXCESS OF BASE, WHICH IS EXTRACTED FROM ALL THE ASHES.

Of all the acids combined with the alkalies, the carbonic acid is that which deprives them the least of their energy, and which may be taken from them with most facility; it is by means of lime that, from time immemorial, the effect has been produced upon which several chemical arts have been founded,

and particularly that of the soap-makers; but as the existence of carbonic acid was scarcely known formerly, the art of combining it with lime, by taking it from the alkalies, is felt, even at the present time, as a consequence of the ancient imperfection of chemical knowledge. Although for more than five-and-twenty years the theory of the various carbonates seems to leave nothing more to be desired, we have not even yet any certain rules for the caustification of the alkalies by lime.

Experiments prove that the potash furnished by the combustion of all the vegetables, is a salt with excess of base, in which the proportions of carbonic acid and potash are constantly the same; so that 100 parts of sulphuric acid always displace by their saturation only forty parts of carbonic acid, when we employ any of the potashes of commerce; while, if, we saturate these same 100 parts of sulphuric acid by truly neutral carbonate of potash, we constantly displace 84 parts of carbonic acid. We know that heat takes from the carbonate of potash only a portion of its acid; it is therefore probable that this quantity of carbonic acid remaining in the potash of commerce is constant, which even the heat of incineration cannot diminish; and likewise that, after having exposed carbonate of potash to this degree of heat, we shall find that it has not retained either more or less of carbonic acid than the potash of commerce, relative to the alkali-metrical degrees respectively found in these salts.

Chemists who repeat these experiments will find that pearl-ashes give a less proportion of carbonic acid; it is probable that this is to be attributed to some circumstances of the process during which the ashes or the ley has absorbed a little less of the carbonic acid, which is both formed during combustion, and is found in the atmosphere. This slight difference would explain why some manufacturers prefer the white potash of Russia to pearl-ash. Thus although a long exposure to the air may increase the proportion of carbonic acid in the potash of commerce, this does not prevent us from distinguishing two constant states of the carbonate of potash by applying this name to the truly neutral carbonate only, and by denominating the potash of commerce *supersaturated carbonate of potash*; as the borax of commerce with an excess of base has been called *supersaturated borate of soda*.—[It is now generally agreed in England to call this salt a sub-borate of soda; and the preposition *sub* is prefixed to all other salts with an excess of base; the potash of commerce is therefore a sub-carbonate.]—It must be admitted that between these two states of *carbonate*

of potash and *supersaturated carbonate of potash*, we may create intermediate degrees in all proportions, when by combining the carbonic acid with the latter we stop before having saturated all the alkali.

Some authors have designated as *alkaline carbonate of potash* the salt with an excess of base; but although this denomination may seem at first view more natural, we ought to prefer that derived from the principles of the nomenclature, from which we cannot depart without replunging the language of chemistry into the confusion from which it has been so happily extricated: in fact, the carbonates of potash, soda, and ammonia, are alkaline carbonates, however neutral they may be: the denomination of alkalescent carbonate is not more proper, because this would indicate a successive diminution of the proportion of acid.

There can be no doubt as to the uncertainty which prevails with respect to the caustification of the alkalies, even in the most recent treatises on chemistry: to quote only one example among all those which might be collected. Fourcroy observes in one place, that "*in order to obtain pure potash we must mix it with double its weight of lime, and eight or ten times the weight of the total mixture of rain water*; we must boil them for two or three hours, filter and draw off the clear lixivium, this we must try by lime-water, which it ought not to precipitate; *otherwise we should again pass it over quicklime.*" On the other hand, in another part of his work, the same chemist says, "*we must mix the carbonate of potash with half its weight of quicklime*, upon which it must be strewed. Water should then be thrown over it, in order to slake the lime; it is afterwards diluted; it absorbs carbonic acid; it passes to the state of carbonate of lime, which is insoluble, and the potash remains pure and caustic in the liquor."

Here it will be observed that, in the first quotation, it has been prescribed to mix the potash with *double* its weight of lime, while in the second article no more than *one-half* is demanded; it is true, that less is required for the truly neutral carbonate of potash, because it contains a less quantity of alkali, and because the water of crystallization is in greater proportion than in the supersaturated carbonate of potash: but if we consider that the richest in alkali (being that which is obtained from cream of tartar) absorbs only 0.72 of its weight in sulphuric acid, while the quantity absorbed by the carbonate is 0.50, we must admit that the proportions indicated in the two cases are no longer relative to each other.

On the other hand, numerous experiments, made on a large scale, have constantly proved to the Author that four-tenths of lime are sufficient to take off the carbonic acid from the best potash of commerce. How happens it, therefore, that twenty-tenths have been prescribed, and fears still entertained that the potash was not perfectly caustic? The reasonableness of this fear has been justified by experience, and the fact upon which the effect depends, though before unknown, is, that whatever be the proportion of the lime to the supersaturated carbonate of potash, if the proportion of water to this salt is not as seven to one, there will be a quantity of carbonate not decomposed, and proportionate to the deficit of water in the seven parts which are strictly necessary. Besides, if we consult the tables of Bergman, as to the respective quantities of carbonic acid which are found in the supersaturated carbonate of potash and in the carbonate of lime, we shall see that four-tenths of lime must always be sufficient for taking up all the carbonic acid contained in any given quantity of the best potash of commerce.

But here is a double experiment, which we may verify: Take of quicklime 4 parts; of white potash of Russia, 10 parts; pure water 70 parts: slake the lime with a portion of the water, and dissolve the potash in the remainder: afterwards mix the whole, boil it for a few minutes, then allow it to cool, and restore the whole of the 24 parts, which may have been diminished by the slaking of the lime and the ebullition; mix the added water very intimately; allow the whole to subside, and decant a little of the liquor: you will find upon trying it, that no precipitate is formed in the lime-water, and that it makes no effervescence with the acids.

In the second place, take the same proportions of lime and potash, but add only 50 parts of water to try it; then try the liquor which will result from this, and you will find that it occasions a precipitate in lime-water, and an effervescence with the acids. Finally, add 20 additional parts of water to the first 50, and mix the whole carefully; the liquor, when decanted, will occasion neither precipitate nor effervescence: in a word, the alkali will have become caustic in consequence of the extraction of all its carbonic acid. Probably this observation may be usefully applied to the caustification of soda.

We now see clearly the reason why we cannot obtain a perfectly caustic alkali, if we do not add a sufficient quantity of water to the mixture of lime and supersaturated carbonate

of potash. Although it might be thought we have used too much lime already, yet we must put still more into the mixture but as it might become too thick, we are under the necessity of adding a new portion of water, which alone completes the caustification, although this has been, nevertheless, attributed to the new addition of lime.

Lastly, we see the reason why, from a mixture of lime and of supersaturated carbonate of potash, with too little water, the first lixivium, which may be filtered, will be effervescent, while that which may be obtained from washings, *i. e.* by the addition of a new quantity of water, will come off entirely caustic.

These alternatives might take place upon the execution of the second of the processes, already quoted from Fourcroy, because the proportion of water is then indeterminate; while in the first process, if it be equal to eight or ten times the total weight of the supersaturated carbonate of potash and lime, it is evident that we ought consequently to obtain potash totally deprived of carbonic acid, if we have never, by the ebullition prescribed of two or three hours, reduced the proportion of water to a less quantity than seven times the weight of the supersaturated carbonate of potash: there seems to be no doubt, that an ebullition of a few minutes is at all times sufficient.

In connexion with the present subject, the Author has observed, that lime burned by means of wood fuel, always contains potash. A knowledge of this fact may often be useful; for example, the water first drawn off lime is often observed to have peculiar properties, and some sugar-refiners are at a great expense in order to obtain it, when the use of a little potash and lime would answer their purpose. Hence we may explain the decomposition of a very small quantity of muriate of soda effected by a large quantity of lime; and trace the origin of the salt which some have asserted to exist in lime. We are also taught to avoid, in chemical experiments, the use of lime prepared with vegetable fuel, as the potash might tend to give false results; and in the medical use of lime-water, it may be also proper to pay attention to the lime employed, and to consider whether the caustic potash which may be in it will not be injurious.

Note.—That the preceding paper may be more clearly understood by those who are not acquainted with the relation of the weights and measures named in it to those used in

England, the following table is subjoined for the purpose of reference:

1 Decilitre is equal to	6.10280 English cubic inches.
1 Gramme	15.4457 English troy grains.
1 Decagramme	10 grammes.
1 Hectogramme	100 grammes.
1 Kilogramme	1000 grammes.

Method of preventing the total Loss of a Ship's Rudder, when its supports are destroyed.

This invention has met with the approbation of the first practical seamen; it has also the recommendation of being fitted without inconvenience or expense: it is calculated to benefit all vessels that have two rudder heads, or two holes for the tiller, which is the case with all men of war and Indiamen.

As it is from misfortune chiefly that experimental knowledge is gained at sea, when combating with contending elements, and each hour aggravating former calamity; the mariner thus furnished with one great resource, may find his ideas strengthened by exigency, and surmount with ease other surrounding dangers. But the frequent disasters which have hitherto happened, point out the necessity of some certain plan, to prevent this misfortune; for it is a just remark, that few ships beat off their rudder, by striking on the ground, without losing them altogether; such was the case with the Royal George, and the Namur, in Torbay, and a vast number of other vessels which might be mentioned, as having suffered the same loss within a short period.

Foreign vessels, in general, endeavour to guard against losing their rudder altogether, but their attempts have been ineffectual; their plan is to have a strap or rope from the main-piece of the rudder to a hole in the stern-post at the water's edge; but this expedient has always proved of small avail; for, without doubt, the violence which can so shatter and destroy the iron-work, will undoubtedly carry away the strap: not to bring forward any idea of its being chafed and rotten in long voyages.

The present plan has in view the saving of the rudder, when it is beaten off, and it serves likewise to keep it in its proper place; for it is remarked, that no iron-work (that is, the pintles and gudgeons on which the rudder turns) can withstand the violence of the ship's striking the ground; but in this invention, when the iron work is carried away, it follows that the fid will still support the rudder, by resting on the comings, and act as an upper gudgeon; nor indeed can any thing force it away, unless the rudder is beaten to pieces. It would be prudent to make additional rudder-pendants, when the rudder is beaten off, which is easily done, by clinching hawsers round the rudder, on each side of the ship, and slipped well down the rudder, to keep the lower part as quiet as possible; but this and many other precautions will occur to the mariner himself, after he has been so fortunate as to save his rudder.

The plate will further illustrate this description: AA, fig. 3, plate XXXIII, is a square fid, made to fit the upper hole of the rudder, and bolted through the rudder head.

BBB, a coming, fitted round the rudder hole, and well secured to the deck, for the fid to work on, and acting as an upper gudgeon, in case the pintles are beaten off.

CC, palls bolted through the fore-part of the coming, to quiet the rudder, in the room of chocks, in case the tiller should be carried away.

It has hitherto been the custom, in a gale of wind, when the tiller is broken, to endeavour to steady the rudder, and prevent the violence of the sea from injuring it, by letting down chocks or wedges; but this method must necessarily be liable to endanger it, by straining the pintles and gudgeons; consequently, to the great distress of many ships deeply laden, has never been found to answer the desired purpose. To effect the purpose in a better manner, it is proposed, that the coming, BBB, which incloses the head of the rudder, should have holes bored at convenient distances, to receive bolts or palls, of between two and four inches in diameter, and about fifteen inches in length, according to the size of the ship: these bolts being placed on each side of the fid, AA, when occasion requires, will confine the helm in any position, and not only give an opportunity to shift a tiller, but will likewise, if necessary, take off any strain from it when lying to.

Processes employed for finishing the Inside of the Palaces of the Native Princes in some parts of the East Indies.

The principal workman employed by Colonel Close in repairing the palace in the *Laul Baug*, gave the Author of this extract the following account of the processes used for finishing the inside of the palaces at Seringapatam.

At first sight, one would imagine that much gilding is used in the ornaments; but, in truth, not a grain of gold is employed. The workmen use a paper covered with false gilding. This they cut into the shape of flowers, and paste these on the walls or columns. The interstices are filled up with oil colours, which are all of European preparation.—The manner of making this false gilded paper is as follows:

Take any quantity of lead, and beat it with a hammer into leaves, as thin as possible. To twenty-four parts of these leaves add three parts of English glue, dissolved in water, and beat them together with a hammer, till they be thoroughly united, which requires the labour of two persons for a whole day. The mass is then cut into small cakes, and dried in the shade. These cakes can, at any time, be dissolved in water, and spread thin with a hair brush on common writing paper. The paper (when dryed) must be put on a smooth plank, and rubbed with a polished stone till it acquires a complete metallic lustre. The edges of the paper are then pasted down on the board, and the metallic surface is rubbed with the palm of the hand, which is smeared with an oil called *gurna*, and then exposed to the sun. On the two following days the same operation is repeated; when the paper acquires a metallic yellow colour, which, however, more resembles the hue of brass than that of gold.

The *gurna* oil is prepared as follows:—Take three-quarters of a maund (abont 18 lb.) of linseed oil, half a maund (12 lb.) of the size called *chunderasu*, and a quarter of a maund (6 lb.) of *musambra*, or aloes prepared in the country. Boil the oil for two hours in a brass pot. Bruise the *musambra*; and, having put it into the oil, boil them for four hours more. Another pot having been made red hot, the *chunderasu* is to be put into it, and will immediately melt. Take a third pot, and, having tied a cloth over its mouth, strain into it the oil and *musambra*: these must be kept in a gentle heat, and the

chunderasu added to them gradually. The oil must be strained again; and it is then fit for use.

The *chunderasu* is prepared from the milky juice of any of the following trees: (*ficus glomerata*, Roxb.,) *goni* (a tree which the Author calls *ficus gonia*,) Bayla, Bayvina, Gabali, &c. It is therefore an elastic gum.

The oil used for painting consists of two parts of linseed, and one part of *chunderasu*.

In white-washing their walls, over the *chunam*, or lime plaster, the workmen of Seringapatam first give a thin coat of *suday*, or fine clay; which is mixed with size, and put on with a hair brush. They next give a coat of whiting, made of powdered *balapum* or *pot-stone*; and then finish with a coat composed of eight parts of *abracum*, or mica, one part of powdered *balapum*, and one of size.

The *abracum* is prepared from white mica, by repeated grindings, the finer particles being removed for use by washing them from the grosser parts.

The wall, when finished in this manner, shines like the scales of a fish, and when the room is lighted has a splendid appearance: but in the day-time, the wall washed with the powdered pot-stone alone, looks better than when washed with either quicklime or mica.

Description of a Capstan, which works without requiring the Messenger or Cable coiled round it to be ever surged.

As few but mariners understand the manner in which cables are hauled aboard in large ships, it will probably render the object of this invention more manifest, to give some account of this operation.—Cables above a certain diameter are too inflexible to admit of being coiled round a capstan; in ships where cables of such large dimensions are necessary, a smaller cable is employed for this purpose, which is called the *messenger*, the two ends of which are made fast together so as to form an endless rope, which, as the capstan is turned about, revolves round it in unceasing succession, passing on its course to the head of the ship, and again returning to the capstan. To this returning part of the messenger, the great cable is made fast by a number of small ropes, called nippers, placed at regular intervals; these nippers are applied, as the cable enters the

hawse-hole, and are again removed as it approaches the capstan, after which it is lowered into the cabin tier.

The messenger, or any other rope coiled round the capstan, must descend a space at every revolution equal to the diameter of the rope or cable used; this circumstance brings the coils in a few turns to the bottom of the capstan, when it can no longer be turned round, till the coils are loosened and raised up to its other extremity, after which the motion proceeds as before. This operation of shifting the place of the coils of the messenger on the capstan is called *surging the messenger.* It always causes considerable delay; and when the messenger chances to slip in changing its position, which sometimes happens, no small danger is incurred by those who are employed about the capstan.

The first method the Author knows of, as used to prevent the necessity of surging, was by placing a horizontal roller beneath the messenger, where it first entered on the capstan, so supported by a frame, in which it turned on gudgeons, that the messenger in passing over it was compelled to force upwards all the coils above the capstan, as it formed a new coil.

This violent forcing of the coils upwards along the barrel of the capstan not only adds considerably to the labour in turning the capstan, but from the great friction which the messenger must suffer in the operation, while pressed so hard against the capstan, (as it must be by the weight of the anchor and strain of the men,) could not but cause a very great wear and injury to the messenger, or other cable wound round the capstan; and that this wear must occasion an expense of no small amount, must be manifest on considering the large sums which the smallest cables used for this purpose cost.

The next method applied to prevent surging, was that for which Plucknet obtained a patent, the specification of which may be seen in the Repertory of Arts, No. 46. In this way a number of upright puppets or lifters, placed round the capstan, were made to rise in succession, as the capstan turned round by a circular inclined plane placed beneath them, over which their lower extremities moved on friction wheels; and these puppets, as they rose, forced upwards the coils of the messenger on the barrel of the capstan. This was a superior method to the first, as the operation of forcing upwards the coils was performed more gradually by it; but still the wear of the messenger, from the lateral friction in rising against the whelps of the capstan, remains undiminished.

The third method used for the same purpose, was that

proposed by Captain Hamilton. It consisted in giving the capstan a conical shapè, with an angle so obtuse, that the strain of the messenger forced the coils to ascend along the sloped sides of the barrel. The roller first mentioned was sometimes used with this capstan, of which a full account is inserted in the Repertory of Arts, vol. ii. The lateral friction, and wear of the messenger against the whelps of the capstan, is equally great in this method as in the others; and it, besides, has the inconvenience of causing the coils to become loose as they ascend; for as the upper part of the barrel is near a third less in diameter than the lower part, the round of the messenger that tightly embraced the lower part, must exceed the circumference of the upper extremity in the same proportion.

In the method to be proposed of preventing the necessity of surging, none of the lateral friction of the messenger or cable against the whelps of the capstan (which all the other methods before mentioned of effecting the same purpose labour under,) can possibly take place, and of course the wear of the messenger occasioned thereby will be entirely avoided in it, while it performs its purpose more smoothly, equally, and with a less moving power than any of them.

This new method of preventing the necessity of surging, consists simply in the addition of a second barrel or capstan of less dimensions to the large one; beside which it is to be placed in a similar manner, and it need not in general exceed the size of a half-barrel cask. The coils of the messenger are to be passed alternately round the large capstan and this small barrel, but with their direction reversed on the different barrels, so that they may cross each other in the interval between the barrels, in order that they may have the more extensive contact with, and better gripe on each barrel. To keep the coils distinct, and prevent their touching each other in passing from one barrel to the other, projecting rings are fastened round each barrel, at a distance from each other equal to about two diameters of the messenger and the thickness of the ring. These rings should be so fixed on the two barrels, that those on one barrel should be exactly opposite the middle of the intervals between those on the other barrel: and this is the only circumstance which requires any particular attention in the construction of this capstan. The rings should project about as much as the cable or messenger from the barrels, which may be formed with whelps, and in every other respect, not before mentioned, in the usual manner for capstan barrels, only it may be recommended to form the whelps without any incli-

nation inwards at the top, but to stand upright all round, so as to form the body of the capstan in the shape of a polygonal prism, if the intervals between tho whelps are filled up, in order that the coils may have equal tension at the top and at the bottom of the barrels, and that the defect which conical barrels cause in this respect may be avoided.

The small barrels should be furnished with falling palls as well as the large ones; a fixed iron spindle ascending from the deck will be the best for it, as it will take up less room. This spindle may be secured below the deck, so as to bear any strain; as the small barrel need not be much above half the height of the large barrel, the capstan bars can easily pass over it in heaving round, when it is thought fit to use capstan bars on the same deck with the small barrel. At two turns of the messenger round both barrels will be at least equivalent to three turns round the common capstan, it will hardly ever be necessary to use more than four turns round the two barrels.

The circumstance which prevents the lateral friction of the messenger in this double capstan, is, that in it each coil is kept distinct from the rest, and must pass on to the second barrel, before it can gain the next elevation on the first, by which no one coil can have any influence in raising or depressing another; and what each separate coil descends in a single revolution, it regains as much as is necessary in its passage between the barrels, where in the air and free from all contact with any part of the apparatus, it attains a higher elevation, without a possibility of friction or wear.

This double capstan has been described, as it is to be used in large vessels, where messengers are necessary, from the great size of the cables; but it is obvious that it is equally applicable in smaller vessels, as their cables can be managed with it in the same manner as is directed for the messenger. The same principle may also be easily applied to windlasses, by having a small horizontal barrel placed parallel to the body of the windlass, and having both fitted with rings, in the same way as the capstan already described. The proper place for the small horizontal barrel is forward, just before the windlass, and as much below its level as circumstances will admit; it should be furnished with catch-palls as well as the windlass.

Besides the advantages already stated, the proposed improvement of the capstan has others of considerable utility. Its construction is so very simple, that it is no more liable to derangement or injury than the capstan itself. Its cost can be

but small, and every part of it can be made by a common ship-carpenter, and be repaired by him at sea if damaged by shot. It will take up but little room, only that of a half-barrel cask; and it is of a nature so analogous to that kind of machinery to which sailors are accustomed, that it can be readily understood and managed by them.

The new capstan, besides the other advantages described above, over other contrivances designed to effect the same purpose, occasions no additional friction or wear to the messenger or cable, which is an object of great consequence. All friction of the revolutions of the cable (or messenger) in passing each other between the barrels of the capstan, is effectually prevented by the whole thickness of one of the rings that passes between each crossing. The contrivance has met with the decided approbation of eminent professional judges. One of these (Henry Peake, surveyor of the Navy,) observes, that he has tried all he could to find some objections to it, but that he has been foiled; and freely offers his exertions to introduce the use of it, if it were only to supersede a plan now creeping into the service, more expensive and much worse than one lately rejected.

The preceding description of the double capstan, will be rendered perfectly clear by the subjoined references to plate XXXIII, fig. 4.

A, represents the larger common capstan used on board ships.

B, another capstan of less dimensions, placed in a similar manner.

C, the coils of the messenger passing alternately round the large and small capstans, but with their direction reversed on the different barrels, so that they may cross each other in the interval between them.

DDDD, projecting rings round each capstan or barrel, so fixed on the two barrels, that those on one barrel should be exactly opposite the middle of the intervals between those on the other barrel.

Method of expanding and contracting a Set of Bars, parallel to the Axis of a Crane.

To have the power of readily contracting the diameter of the barrel of a crane, when the load is great, and an increase of power is required; or of expanding it, when the load is small, and velocity is desirable, must evidently be advantageous. It is supplied in the present machine by ingenious and by no means complicated mechanism.

The reel, fig. 1, plate XXXV, is formed of two parts, figs. 2 and 3. The wheels or circles of fig. 3, are held fast on the spindle or axis of the wheel by pins *a*, and have spiral grooves cut in each wheel, as seen at *b*.

The wheels, fig. 2, have eight long mortises, *c c*, cut in each of them, and are connected with an iron tube *d*, having a flange or collar at each end with screws, *e e*, to fasten the wheels. When all the parts are put together, as in fig. 1, the axis *f*, fig. 3, goes through the tube and wheels fig. 2. so that the two parts are connected.

In fixing the cross bars. one of which is seen detached at fig. 4, the parts between the dotted lines *g g*, slide in the mortises fig. 2; and the small ends or tenons *h h*, slide in the spiral groove fig. 3. When the two parts are locked by the catch, *i*, fig. 1, which has a spring for that purpose, the bars are fast; but when the relative situations of figs. 2 and 3 are altered, by the hook *k* being passed through the hole *l*, as shown in fig. 6, the bars will all remove nearer or further from the centre, by means of the spiral groove *b*, fig. 3, so that the reel may be enlarged or diminished at pleasure.

To set the hands of the workman at liberty, the hook *k*, when the reel is to be altered in its dimensions, must be put into the hole, *l*, so that it shall support the catch, and hold the part, fig. 2, fast at the same time. The handle *m* is then to be turned till the reel is of the size required; when this is done, push out the hook *k*, and the crane is ready for use.

It is necessary to observe, that the tenons, *h h*, must be cut so that the outside of all the bars next the rope shall be at an equal distance from the centre. If the tenon of the first bar that is placed in the reel be cut like the tenons *h h*, fig. 4, the last of them must be cut the same as the tenons *n n*, fig. 4; and all the other tenons, at the extremities of the several bars, must be at proper distances between these extremes, as is shown by the white dots *d*, in the mortises fig. 2.

An Expanding Band-wheel.

In the usual method of connecting machinery, by a band running over two wheels or riggers, it is obvious that the relative velocity of the wheels is in the inverse ratio of their diameters ; and these diameters always remaining the same, no alteration of the velocity can be obtained, but by a corresponding variation in that of the moving power applied.

To enable the artisan to regulate the velocity of his machinery at pleasure, the moving power remaining as before, or to retain the same motion, with an alteration in that of the applied force, is the purpose of this invention. In the plate, two methods are shown of attaining this desirable object ; in both, the periphery of the band-wheel is divided into any convenient number of parts, according to the size of the wheels, (in this case twelve,) which may be placed at any given distance from the centre of the wheel, (within the limits of the machinery,) and thus by enlarging the circumference of one band-wheel, while the other is equally diminished, to alter the relative velocity of each at will. These parts of the periphery, marked by the letters *i i i i*, &c. are confined to move in grooves, cut in the large wheels A and B, fig. 1 and 2, plate XXXVI, in the direction of their radii, and are moved by a spiral thread in the small wheel C, which thread takes in the teeth of the racks on which the parts *i i*, &c. are fixed.

A part of the shaft on which the wheel A is fixed, is made circular, to admit the small wheel C to turn round independently of the other, and thus to extend or contract the racks, &c. in fig. 3.

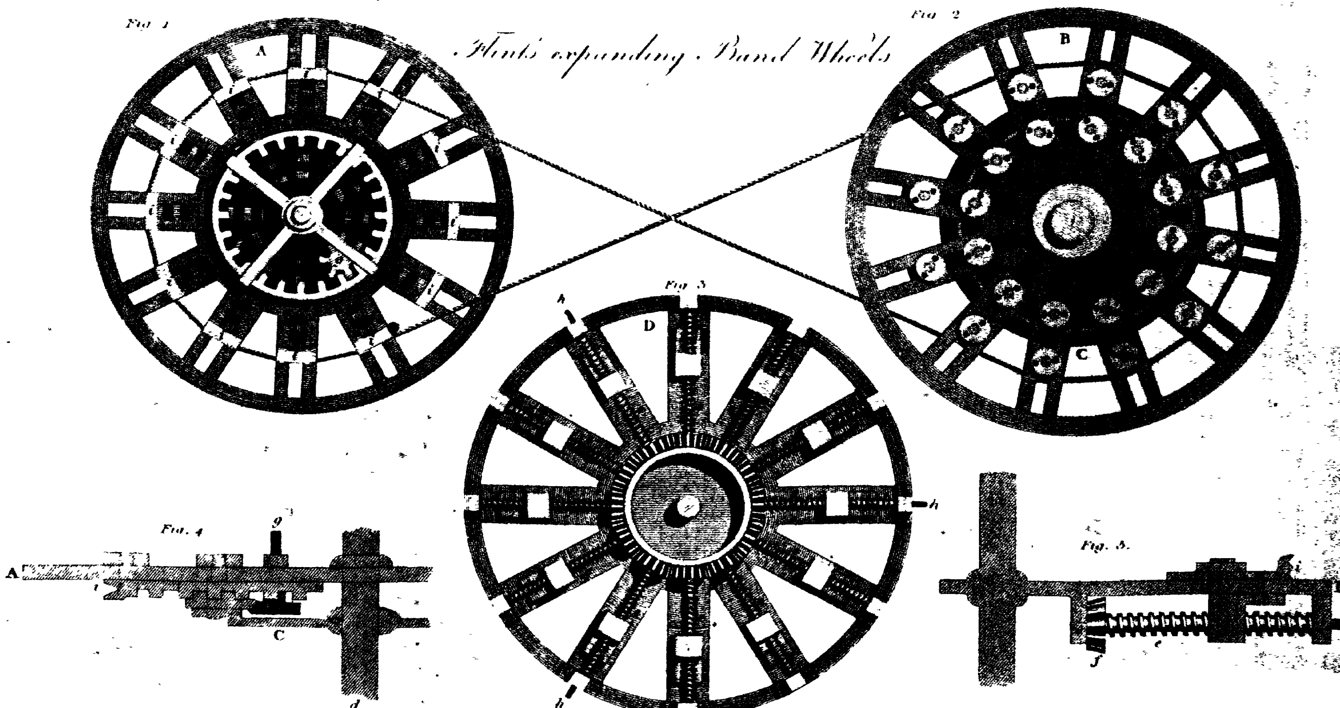
Fig. 4, is a section of part of the rigger, in which the letters refer to the same parts as in figs. 1 and 2.

In the wheel D, the same effect is produced by the screws *e e*, &c. which are made alternately right and left handed, and turn with equal motions by means of the equal bevel-wheels *f f*, &c. fixed at their ends near the axis of the wheel. Fig. 5 is a section of the same.

The wheel C, figs. 1 and 2, is moved round the shaft *d*, by the pinion *g*, on the axis of which is fitted occasionally a winch.

The screws of the wheel D, fig. 3, may also be turned by means of a winch applied to their projecting heads *h h h*. It is proper to notice that the series of screws must always consist of an even number.

Flint's expanding Band Wheels



Construction of Sash-windows, which may be cleaned or repaired without the Necessity of any Person going to the Outside of the House.

Servants and others employed in the cleaning an repairing of sash-windows, in general provide so indifferently for their security while employed on the outside, that numerous accidents occur. One circumstance of this kind, which immediately led to the present invention, was that of a man standing on a board cleaning the outside of a window, when the board giving way, the man was impaled upon the railing of the area below, whence he was conveyed to the hospital without hopes of recovery. This unhappy person had a large family depending upon him for subsistence. Various other accidents, of an equally deplorable nature, have been owing to the same cause. The construction of sash-windows now proposed, will not only effectually prevent these accidents, but will remain a permanent convenience to the house in which it is adopted. In appearance, the new sash resembles a common sash, and the upper or lower sheet may be moved up and down in a similar manner; besides which, by pushing back two small springs in the upper sheet, and at the same time pulling the sash inwards, the outside of the sash is turned into the room; so that it may be easily painted, glazed, or cleaned, by a person standing within the room, without the necessity of removing the slips or beadings, by doing which, in the common mode, the glass is frequently broken, and the beads lost, left loose, or dismatched, and a considerable expense incurred.

By turning the lower sash of this window, into a horizontal or inclining direction, a person may look into the street without being wet in rainy weather, or the rain driving into the room and damaging the furniture. Old windows may be altered to act upon this principle, at an expense of twelve shillings per window; and in making new sashes and frames, the improvement will add but six shillings to the common price.

AA, fig. 1, plate XXXVII, represents the window-frame: BB the lower, and CC the upper sash.

The frame AA is fitted with grooves, weights, and pulleys, in the usual manner; the fillets on the sash, which enter the grooves, are not made in the same piece with the sash-frame, but fastened thereto by pivots about the middle of the sash; upon these pivots the sash can be turned as at CC, so as to get

at the outside without disturbing the fillets or grooves. When the sash is placed vertically, as BB, two spring catches, at *a a*, shoot into and take hold of the sliding fillets, so that in this state the sash slides up or down in the usual manner, but can be immediately released, and turned inside out by pushing back the springs, and at the same time pulling the sash inwards; this turns the outside towards the room, so that the sash may easily be painted, glazed, or cleaned on the outside by a person within the room, without removing the beads which confine the sash to slide up and down vertically. By inclining the sash on its pivots, so that the highest point may be within the room, it is obvious that the window may be left open in the most severe rain, without admitting a drop to enter the room, and that a person may look into the street without being wet.

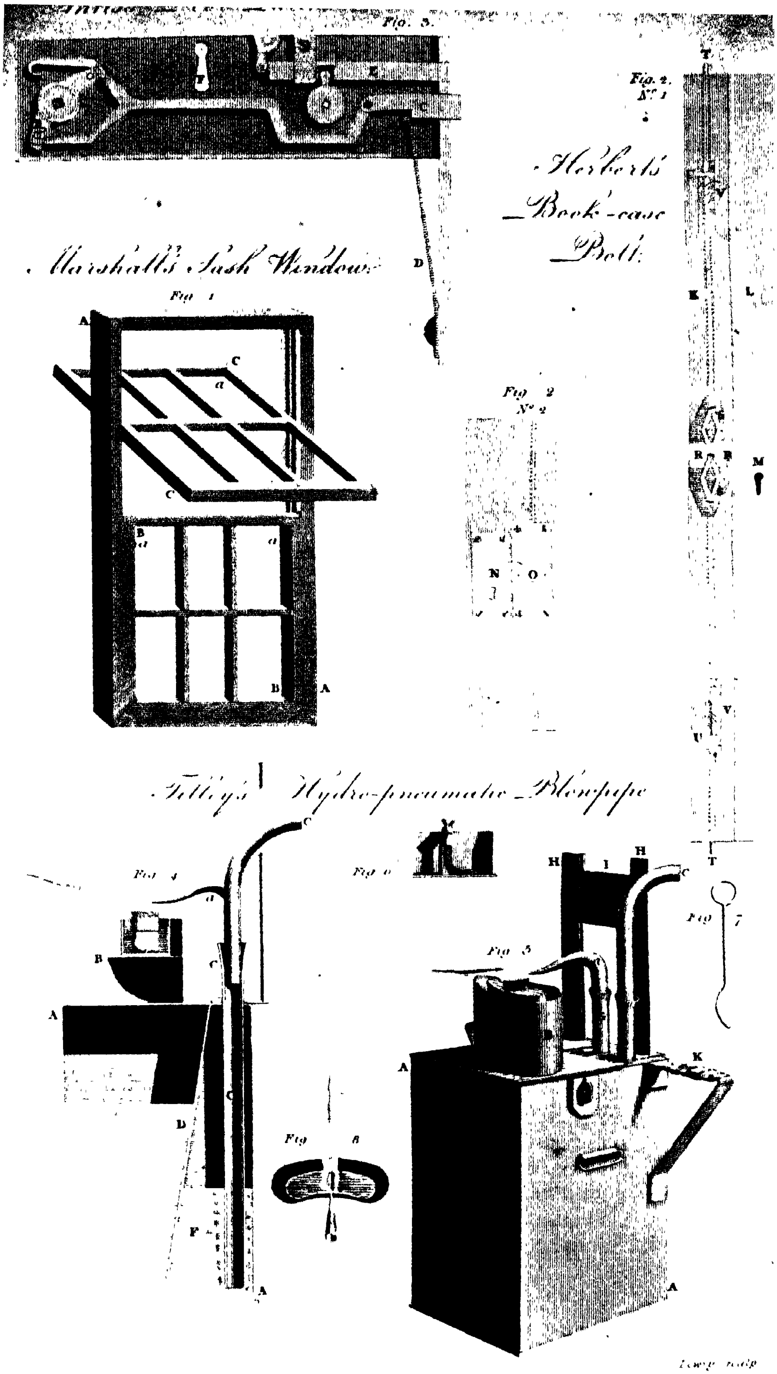
A Book-case Bolt, by which both Doors are secured and opened at once.

KL, fig. 2, plate XXXVII, represents the two styles of the doors of a folding book-case.

M, the keyhole of a lock with two bolts, which are more clearly shown at fig. 4, where the back of the lock N shows the two bolts of the lock pressing back a sliding piece O: on the front part of this sliding piece, in fig. 3, two small friction rollers are placed at P, in the act of pressing against two levers, crossing on one common fulcrum R, to each end of which, shorter levers SS, above and below, are connected by joints. These short levers act upon two long bolts, whose extremities are shown at TT, having each a helical spring at VV.

In the state as engraved, the doors are locked and bolted. On drawing back the bolts of the lock by means of the key, the helical springs VV, press against the plates UU, through which the long bolts pass; they force back the long bolts and sliding-piece O; and allow both the doors to open.

Although this contrivance was originally designed for a library book-case bolt, to facilitate the opening of both doors at once, and to secure the same, without the trouble of bolting or opening two bolts as in the common construction, yet its


Fig. 3.
Fig. 2.
No. 1
Herbert's
Book-case
Bolt.
Marshall's Sash Window.
Fig. 1
Fig. 2
No. 2
Tilley's Hydro-pneumatic Blowpipe
Fig. 4
Fig. 6
Fig. 5
Fig. 7
Fig. 8
Lowry sculp.

application may evidently be extended. For example, it will answer for wardrobes, French casements, or folding sash-doors. It will also make a good sash fastening, if let into the bottom sash, with a small brass knob to slide as in the common way; it would bolt in the frame by the side of the sash-cord, both sides at once.

Improved Door Latch.

The latches used for the inner doors of houses, are extremely liable to be out of order, and to avoid the trouble of having them taken off and repaired, are often allowed to remain some time in that state, which occasions considerable inconvenience. The latch described below is not more expensive than the old ones, but it is more simple, less liable to be out of repair, and has the advantage of requiring no oil or cleaning.

Fig. 3, plate XXXVII, A shows the hole for the handle, which moves the follower and latch.

8. The follower, which draws back the latch, on turning the handle either way.

C, the latch.

D, the longitudinal spring, which throws out the catch of the latch when the hand is withdrawn.

E, the small bolt to secure the door internally.

F, the key-hole, the bolt of the lock of which is not shown, being placed above the key-hole.

A Furnace or Evaporator for the Use of Chemists, Preparers of Salts, &c.

Fig. 1, plate XXXVIII, is a view of the whole furnace or evaporator complete.

Fig. 2, a section lengthwise of the boiler, fire-place, &c.

Fig. 3, a transverse section of the boiler and flues, looking towards the fire-place.

Fig. 4, a plan, from A to B, of fig. 2.

Fig. 5, a plan from C to D.

Fig. 6, a plan from E to F.

Fig. 7, a plan from G to H.

a, The opening or hole through which the air enters; and being admitted through the three holes *b b b*, passes over the surface of the liquor in the cistern or boiler *x*, and then passing again by similar openings, at the opposite end of the cistern *y y*, descends by the vacuity *c c*, and by the holes *d d*, is conveyed, by the passages *e e*, to the ash-hole or under side of the grate, and thus serves to actuate the fire, bringing with it the steam arising from the boiler.

The air and steam, having thus served the purpose of actuating the fire, are, with the smoke arising from the fuel, conveyed by the back of the furnace *g g*, under the boiler, along the passage *h h*; and rising through an aperture *i i*, under an inclined cast-iron plate *k k*, passes through two holes *l l*, into the passages *m m*, and rises by two other holes *n n*, into a vacuity *o o*, whence it arises again, by two holes *p p*, enters the flues *q q*, and thence into the chimneys *r r*.

s s, the stoking-hole of the furnace.

t t, The ash-hole.

VV, The opening through which the fuel is put into the furnace.

W, the door or opening to the cistern.

The same letters refer to the same parts in all the figures.

This furnace or evaporator might be employed advantageously in the drying of malt, as the heat is more equally dispersed, and the vapour carried off much quicker, than by the mode now practised. With respect to its general advantages, it may be observed, that it does not require one half of the fuel or attendance that boilers do; as it need only be supplied with liquor or fuel once in twelve hours, or even once in twenty-four hours; for the fire being confined, in the first instance, to the bottom, and the evaporation being regular, a certain quantity either of fuel or liquor may be put in at certain times. As the atmosphere is rendered of an equal heat with the liquor, more moisture is by this means carried away than by any plan in which is this not attended to. Nor should it be overlooked, that as the air necessary to keep the fuel in combustion passes over the surface of the liquor, every pernicious vapour is carried with it into the fire, where it is decomposed, or at least so changed as to be no longer pernicious.

Method of equalizing the Motion of the Sails of Windmills.

This invention forms the subject of a patent, the specification of which is dated May 9, 1807; it consists in applying to windmills an apparatus which causes the vanes to regulate themselves, so as to preserve a uniform velocity under those circumstances in which the wind would otherwise irregularly impel them, as is the case with the sails or vanes of mills of the present construction. In accomplishing this object, the vanes, for the sake of lightness, are formed with fewer cross bars or shrouds than in the common method, and the open spaces are filled up with small flat surfaces, formed either of boards or of sheet iron painted, or other fit substance—perhaps a framing of wood covered with canvass is the best. These flat surfaces are hung or suspended on their ends by gudgeons, pivots, centres, joints, or any other convenient method, so as to open and shut like valves, by which name we may hereafter distinguish them in this essay. The centre of motion should be as near the upper longitudinal edge of the valves as possible, as shown at *b b*, fig. 1, plate XXXIX, where a valve, upon an enlarged scale, is drawn detached. These valves may be applied to vanes of the present construction, by suspending them to the cross bars or shrouds of the vane by their longitudinal edges.

The vanes constructed with valves as above described, and which are represented by fig. 2, present a greater or less surface to the wind, according as it acts with greater or less force on them; and if the wind be very strong or high, the valves by its impulse would turn their edges to it, and their broad surfaces parallel to the direction of the wind. The vanes would consequently remain stationary, or at least have but little motion; but to prevent this circumstance from taking place, a contrivance is added, which causes the valves always to present their broad surfaces to the wind, or such portion of their broad surfaces as may be desirable. The apparatus usually applied by the Patentee is shown in figs. 3 and 4, which last figure exhibits two methods of accomplishing the object in view; though it must be evident that various other means may be adopted to produce the same effect.

Fig. 2. represents a set of vanes, in which AA, show the valves turned to the wind, and their broad surfaces exposed at right angles with the direction of the wind

BB, exhibit the vanes as close-reefed, or the valves with their edges to the wind, so that it can have no effect upon them except at their edges, which must be trifling. In the plate, the vanes are exhibited as having the whip down the middle, with valves on both sides; but it is evident that the vanes may be constructed with the whip placed in the usual way, and have valves on one side only, which plan the Patentee usually adopts in applying his invention to vanes of the common form.

Fig. 3, represents a side-view of the apparatus for regulating the valves; and fig. 4, is a section of the same, exhibiting two methods of performing this operation.

A, fig. 4, represents the shaft, which is bored through its centre, to admit an iron rod B, to pass freely through it; one end of this rod is made to turn in a box C, which is fastened to a toothed rack D, whose teeth take into those of a pinion E, upon the axis of which is a sheave F, with a groove on its circumference to receive a rope G, to which is hung a weight, (shown at H, fig. 3,) and which must be sufficient to regulate the force of the wind upon the valves, though no precise weight can here be specified, as it must be adjusted by experiment, or by the quantity of work the mill is designed to perform.

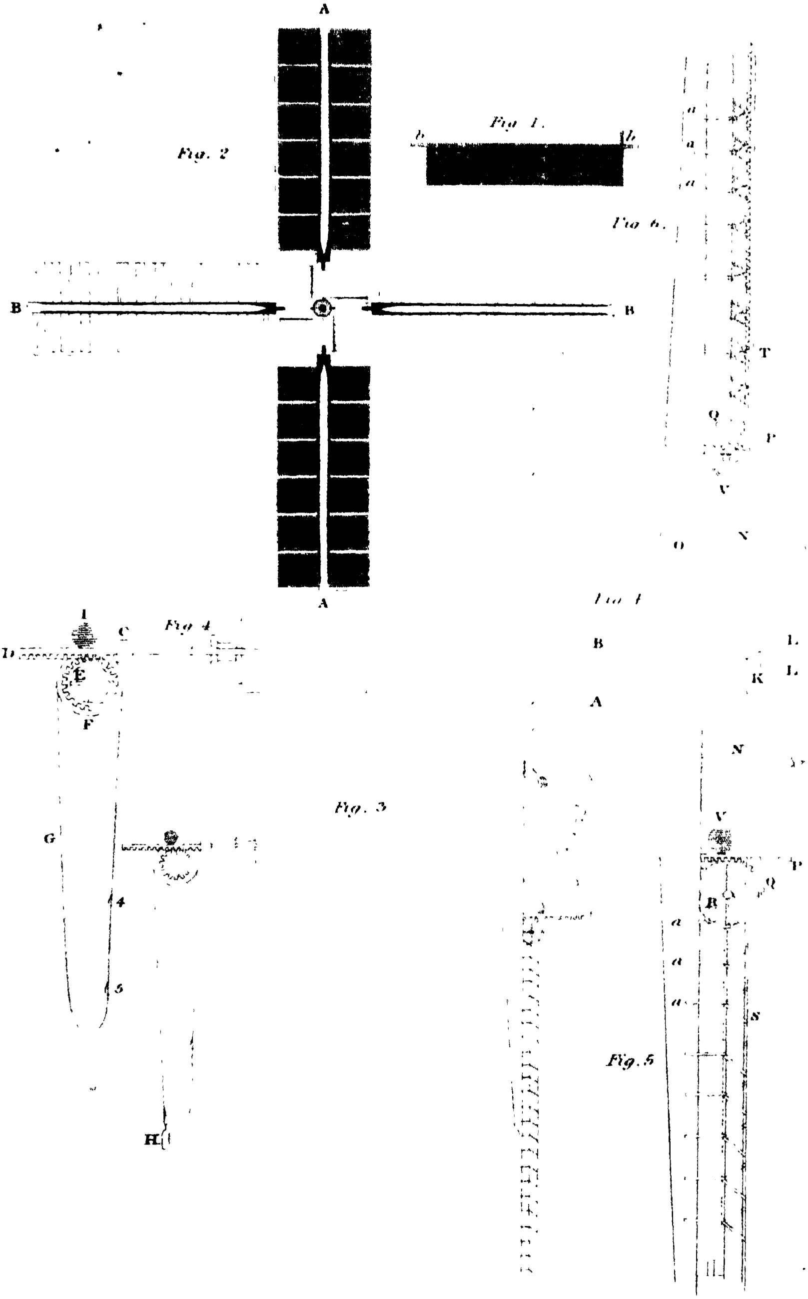
Over the top of the rack D, is a roller I, which serves to keep the rack and pinion in the proper depth of gear.

The end of the rod B, which turns in the box C, has a knob on it, by which it can be moved endwise while it is turning in the box C. In the other end of the rod, is fixed a boss or plate of iron K, with a gudgeon projecting from each side, on which are the bridles or leaders LL. These leaders permit the levers MM to describe a curve with their ends, while the iron rod B moves in a straight line.

NN are two studs or props fixed to the stock O of the sail; on the ends of which props the levers MM move, and communicate their motion to the racks PP, the teeth of which take into the pinions QQ, on the axis of which (according to the method exhibited at fig. 5) is fixed a strong iron stud R, which is attached to a rack or slider S. Iron studs or levers are fixed at one end in this slider S, by a pin or gudgeon, and at the other made fast to the valves *a*, which move on gudgeons as before described.

The other method of regulating the valves is shown at fig. 6. where, instead of the studs or levers, the valves may be moved by having pinions fixed to them, and working with teeth in a

Cubitt's Mode of equalizing the Motion of the Sails of Windmills.



Published by Henry Fisher Caxton, London 1822

rack or slider, as at T. VV are rollers, to keep the racks PP in their gear.

The operation of this apparatus will be clearly comprehended by imagining that if the hook 4 on the rope G be pulled down to 5, the sheave F with the pinion E will turn at the same time, putting in motion the rack D, with the rod B, which will bring the levers MM into the position represented by the dotted lines; the racks P will have turned the pinions QQ, till the sliders S and T, with the studs or levers, or racks, (according to the method used,) bring the valves into the position of the dotted lines, in which position they are represented as having all their surfaces to the wind; therefore, if a sufficient weight be hung to the hook 4, the weight will descend to 5, and keep the valves in the situation of the dotted lines; and supposing the wind to blow upon them with too much force in this state, they will turn on their gudgeons, and raise the weight, so that the superfluous wind will pass through or between them, without exerting an irregular force upon the vanes, so as to produce an unequal velocity.

The Patentee observes, that the advantages peculiar to this new mode of equalizing the motion of windmill sails, will appear more striking by a comparison with the inconveniences of those heretofore used, whether those of the common sort, or those that reef themselves by means of their centrifugal force. The first require the constant attention of the miller to every gale of wind; and it is frequently with the greatest difficulty and danger that he can get in his cloth quickly enough to avoid the storm; which, if he successfully accomplishes, it is with the loss of much time. With the second, though they save the time and trouble of stopping to reef, they are by no means void of danger, as the sails receive the whole impulse of the gale, and attain a very great velocity before they can reef themselves at all, and thereby cause a motion in the mill as unequal as the wind which turns it; besides the additional wear and tear occasioned by such unequal motion. Should a mill of either of these constructions be left standing still with all the cloth out, and be taken with a sudden gale of wind, great risk is run of losing all the sails; whereas, in such case, the sails above described are perfectly safe, as there can never be more force exerted upon them in any gale, than is sufficient to do the work of the mill, whether they be in motion or at rest, without altering their angle of weather.

Another great advantage is, that when they are close reefed,

they do not present so much surface to the wind as those of any other construction, let them be taken in any direction whatever.

The ease and expedition with which these sails may be reefed, is an additional recommendation to them; especially as they admit of this operation without requiring either judgment or experience in the person by whom it is performed; for by taking off the weight, and pulling the rope, all the sails may be close reefed in the short space of three or four seconds. The invention is therefore likely to prove a valuable acquisition to all those whose business depends on windmills, as it will preserve the mills, and render their motion as steady as that of water-mills. And where the work performed does not necessarily require constant attendance, as in the draining of marshes by windmills, these patent sails may be left at work night or day, with perfect safety.

Description of Inventions for the Improvement of Naval Architecture, for increasing the Comforts of Mariners, and for facilitating Naval Enterprises.

The inventions which form the subject of this essay relate to objects of the greatest importance to a commercial nation: and they show with what success the investigations of genius may be attended, although directed to the most difficult problems of mechanics; and requiring the acquisition of prodigious power. In this point of view, they deserve the attention of every engineer, as well as that particular class whom they more immediately concern.

I. A WROUGHT-IRON MOVEABLE CAISSON WITH A RUDDER, FOR DOCKING A SHIP, WHILE RIDING AT HER MOORINGS, IN ANY DEPTH OF WATER, LEAVING HER KEEL DRY IN A FEW HOURS, WITHOUT REMOVING HER STORES OR MASTS.

This floating dock is made of wrought iron, half an inch thick, 220 feet long, 54 feet wide, and 30 feet deep, and will

weigh about 400 tons, with a flanch six feet wide on the top, for the workmen to stand upon, and also to strengthen the caisson.

The weight of this caisson, when immersed in water, is nearly 350 tons; but, for reasons mentioned below, it is rendered nearly buoyant. being surrounded by an air receptacle capable of suspending the whole weight with great exactness, which is riveted to it in such a manner as also to strengthen the caisson, and support the principal shores from the ship.

This caisson draws nine feet water. When taken to the ship intended to be docked, the water is to be let into it at an opening or plug-hole at the bottom, and it is to be suffered to sink until the upper part is even with the surface of the water, the air receptacle still keeping it buoyant. A small quantity of air is then to be discharged by opening a plug-hole in the air receptacle, until a quantity of water is let in just sufficient to sink the caisson, which is then to be drawn under the ship's bottom. This being effected, the caisson (nearly buoyant) is then to be raised to the surface of the water by ropes made fast from the caisson to each quarter of the ship. A pump placed within the caisson, and worked by a steam engine of 12-horse power, placed in a barge alongside, will empty it in three hours, and reduce the ship's draught of water eight feet; that is, from 26 to 18 feet; when she may be carried up into shoal water, the caisson floating with a draught of only 18 feet of water, while the ship she carries would have required 26 feet. She may then be carried into shoal water, if required, or alongside wharfs, or jetty heads of the dock-yards.

The ship's sides and bottom tending to fall outwards, by its own weight, and the sides and bottom of the caisson tending to be forced inwards, by the external pressure of the water, it is obvious that by placing props or shores between, both will be supported, while the ship will ride with all her stores on board and masts standing, nearly as easy as when floating in the water.

Should inconvenience be apprehended at any time from blowing weather, the caisson may be cast off, and let fall to the bottom, where it cannot be injured, and from whence it may be raised to the ship's bottom again at pleasure, with as little labour as weighing an anchor.

The upper part of this dock will be 12 feet above water when there is a first-rate ship in it; this is a sufficient height to prevent the sea breaking over.

By this means a ship may have her bottom examined, and be out again in six hours, without coming above the Nore, and without undergoing the tedious process of unshipping and re-shipping her stores, or waiting for spring-tides, or fair wind, to enable her to reach to, or return from, dock, which on an average, now requires three months, accompanied with an expence of nearly £10,000 per month in wages, subsistence, &c. &c.

This plan may be practised in all countries, and must be particularly advantageous where there are no dry docks or flowing of tide.

Ships on many foreign stations, when requiring to be docked, are now obliged to be sent home, at a great expense of money and waste of time, others being sent to replace them. This may be avoided in future. Docks made in England may be sent out in pieces of five or six tons, with the necessary rivets and bolts, and ready to be put together wherever they may be wanted.

A caisson capable of docking a first-rate ship will not cost above nineteen or twenty thousand pounds, (for merchantmen and smaller ships, the size and cost will be proportionably less,) and (judging from the duration of wrought-iron *salt-pans*) will last 20 years without repair. When worn out it may be broken up, and will sell for one-third of its original cost.

By adapting caissons to the local circumstances, ships of war and merchantmen, with all their stores and cargoes on board, can be carried to wharfs and store-houses up rivers where the depth of water is not above one half the ship's draught: for example, in the river Clyde the ships may be carried to Glasgow, instead of being obliged to unload twenty miles lower down the river.

II. IMPROVED SYSTEM FOR TOWING SHIPS, FLOATING DOCKS, OR CAISSONS.

This subject, as connected with naval affairs, possesses much importance.

It will readily occur, that there are many instances on record where objects of the first magnitude might have been gained by the help of an improved system of towing vessels, particularly when entering or leaving harbour. But although the system about to be explained is perfectly applicable to

general purposes, it was chiefly with the view of rendering the floating dock complete in all its appendages, that the Patentees were induced to direct their attention to the subject.

With respect to the general application of the system of towing, it will occur, that an apparatus of this description ought to attend every naval expedition. But as those interested in the adoption of such improvements need not be informed of their manifold advantages, it will be sufficient to give a brief description of the new towing apparatus.

The employment of steam-engines for this purpose has no novelty; but, however competent this agent in other respects, it has generally failed in this branch of its application, not from its own incompetency, but from a defect in the communication required between the power and the water upon which it is destined to act; and from not considering that a power insufficient to move a vessel with others in tow, may be sufficient to move them alternately, that is to say, first the vessel containing the engine, and then, by the communicating rope, the vessels which the first mentioned vessel has to move.

A steam-engine of fifty tons weight on board a barge, or ship, will tow with much greater power and effect, while only impelling a vessel forward by the action of the engine against the water, than a thousand men can do with sweeps. But if the same engine is applied to wind up a rope, made fast to buoys, anchors, or any other fixture, the power can be increased to any extent, at the expense of a loss of time merely equal to the effect gained.

Many of the naval harbours in England are so situated that it is a fair wind to go to sea with, when perhaps it blows directly into the harbour's mouth. By the placing of buoys, at about 400 yards distance from each other, this difficulty may be overcome: with an engine of the above description, men of war and transports might be towed out clear of the harbour in a short time.

This may be effected in the following simple manner:—The steam-engine will drive itself in the barge to the first buoy, where it will be made fast, at the same time paying out about 400 yards of tow-rope, or less, as the case may require, one end being fast to the ship to be taken in tow, the other being fastened to a capstan to be moved round by the power of the engine. This movement brings the ship up to the first buoy, where it is made fast, when the engine with the barge starts afresh to the next buoy, and so on until the ship or ships

in tow arrive at the outer buoy. In situations where there are no buoys, anchors may be dropped, and speedily weighed again by means of the steam-engine; but it is only in extreme cases that this routine is necessary. Generally the power of the engine will be found quite sufficient.

The method in which the power of the steam-engine must be applied to this purpose, becomes the next object of consideration. Two methods are proposed. In one of them a revolving wheel is employed, furnished with leaves to lay hold of the water, and worked by the steam-engine. At first sight there appears no novelty in this idea, but the way in which the wheel is disposed of, constitutes its originality and excellence. It is placed in an air-tight receptacle, open only at the bottom, in which the height that the water is permitted to rise (or, in other words, the depth of the dip of the wheel) is perfectly under the command of an air-pump worked by the engine.

A second method in which the steam-engine may be applied is the following. A wheel, or a sufficient portion of a wheel, to which an arm of considerable length is attached, receives an alternating motion by working in a rack on the piston rod of the engine. The arm just mentioned is employed to give motion to a valve or valves included in a hollow trunk or prism attached to, or actually contained in, the vessel, placed longitudinally, and made of a size suited to the effect that is desired. The power of this application will be easily conceived from the following considerations:—When the stroke of an oar, or any similar implement, is made against water for the purpose of obtaining a re-action as nearly as may be similar to that of the resistance of an immoveable body, part of the force is lost in producing a lateral motion in the water, which escapes sideways, and the blade of the oar is far from being stationary. If the oar were to pass in a channel or groove to which it fitted, and of such a length as to present a long prism of water before the oar, which could no otherwise move than by passing out of the channel, it is demonstrable that the mass of the said prism of water may be assumed of such a magnitude as to render the actual motion of the oar by a given force, and during a given time, less than any assignable quantity. The valve or valves working in the hollow trunk, are attached to a rod which is connected with the arm of the steam-engine, and receives a reciprocating motion like a piston, and thus opens and shuts the valves alternately. If the hollow trunk be of sufficient

dimensions, it is evident that its contents will have so much inertia or resistance, as to receive but little velocity from the piston, and that the surplus power must carry the vessel forward in an opposite direction.

If the hollow trunk be made moveable, and attached to the rowing arm, and there be a stop within, of the nature of a valve, to shut against the stroke and open with the return, the effect will be the same as with the former arrangement, but the machinery would probably be more cumbrous, and apt to get out of repair.

III. SLIDING TUBULAR MASTS, MADE OF IRON, AND SO CONSTRUCTED THAT THE UPPER ONES SLIDE INTO THE LOWER, IN A MANNER SOMEWHAT LIKE A POCKET TELESCOPE.

A hollow iron mast, of the thickness of half an inch, and of the same height and diameter as a wooden mast, will be much lighter, considerably stronger, much more durable, less liable to be injured by shot, and can be easily repaired, even at sea. It will weigh only 12 tons, and at £45 per ton, will not cost more than £540, while its strength will be nearly fifty per cent over that of a wooden mast that weighs 23 tons, and costs nearly £1200.

This mast is made to strike nearly as low as the deck, to ease the ship in a heavy sea. Wooden masts are, in such circumstances, obliged to be cut away. Ships furnished with these masts will not, like others, be exposed to the risk of receiving damage from lightning. The iron mast being itself an excellent conductor, by using an iron bolt from the bottom of the mast, through the kelson and the keel, the electric matter will be conducted through the bottom of the ship into the water, without injury to the ship.

Yards and bowsprits may also be made of wrought iron, at the same proportion of strength and expense as the mast. Chain shrouds and stays made of iron* may also be used with

* Since this essay was first circulated, (Feb. 10, 1809,) we have learned that the idea of employing iron rigging has actually been carried into effect, by a Lieut. Brown ; and a vessel rigged in this manner, but with wooden masts, was for some time to be seen in the West India dock, London. The first proposal, however, that we have heard of, for using metal in rigging, was from A. Tilloch, in the year 1801 ; Phil. Mag. vol. xxi. p. 108.

those masts, and will not cost half the expense of rope, while they will also prove ten times more durable. For many other purposes in shipping, wrought iron, employed as a substitute for the materials now in use, would have as great advantage as in the articles above-mentioned. Even the whole hull may be made of wrought iron.

IV. PREPARATION OF SHIP-TIMBERS, AND IMPROVED SYSTEM OF BUILDING.

For a long period, the only means employed to effect the bending of ships' planks, was by exposing them to the heat of open fires, and in most parts of Europe this is still the practice. As hitherto conducted, it has been found to be a tedious, slovenly process, attended with a great expense of fuel, and unequal in its effects, some parts being only partially heated, while others are burnt.

Another system was therefore resorted to, that of employing steam; and it must be allowed that this mode of bending has been found to answer so far as the interest of the ship-builder is concerned; but the ship-owners have suffered from its effects. It is possible by means of steam to give the required degree of flexibility to planks; but steam of a degree of temperature high enough to destroy the vegetable sap, cannot be confined in vessels of any reasonable strength. Wood so treated has been found liable to sudden decay: nor is this, which is an important objection, the only one to which steaming is liable. When planks beyond a certain thickness are bent in this way, they are found to be injured, from the temperature being too low to give the required flexibility; and, owing to the want of a better method, the curving of strong timbers has hitherto been impracticable.

It is well known, that the decay of a ship originates and takes place in the timbers and inside of the planks, by their being precluded from a free circulation of air, to evaporate the natural vegetable sap of the wood.

The process now recommended, is for heating both planks and timbers, without steam, and in such a manner that they may be enveloped, and equally surrounded on all sides with hot air and smoke: the coal-tar contained in the latter entering at the same time the pores of the wood, and acting as a feeder. This process is so conducted, as to prevent the wood from being burnt by it; all the air that reaches the timbers,

while under process, being previously obliged to pass through the fire, and being, by that means, deprived of its oxygen, or that principle which maintains combustion, no burning can take place.

The means employed to effect this, are horizontal curvilinear flues made of cast iron, adapted to the forms intended to be given to the wood, and furnished with a powerful, but simple apparatus for applying the force requisite to bend the timbers into the required form.

By this process, even timbers of large dimensions can be bent to almost any shape. They are heated throughout their whole length and substance, without alternations of temperature in the different parts, as when exposed to open fires.

By this process, the necessity of procuring bent timbers is done away; while, at the same time, that loss which is incurred by cutting straight or ill-shaped timbers into proper forms, is avoided, and that weakness which results from cutting across the grain, and from scarfing, is obviated.

By this process, also, there will be a saving of that time which is necessary, in the ordinary process of ship-building, for *seasoning*, as it is called; and, which is of great importance, much of the labour now bestowed on trimming and chipping, to give form both to straight and crooked timbers, will be avoided, while the natural strength of the pieces will be left unimpaired.

The preparation of ship-timbers, as above-described, applies to the system now in use, in which the framing consists of pieces of wood bent by nature, and brought into form by sawing and chipping. The pieces to which we allude are known by the name of ribs, and much of the strength of the present structure of ships is attributed to them.

But strange as it must appear to those who have never once started a question on the subject, the ribs give but little strength, comparatively, and we propose to discard, almost entirely, from ship-building those pieces called ribs, and to present to our country a system infinitely preferable in point of strength, cheapness of construction, durability, and the facility with which the requisite materials may be obtained.

It may be premised, that the principal defect of the present method lies in this:—The ribs owe what stability they possess in the structure, entirely to the connection they have with the beams, planks, and lining, having but little of their own. Their stability depends on the structure of the planks with which they are covered, and which are attached to them within

and without. They afford little or no direct support to each other; and hence the facility with which the ship breaks in two, when by any accident the ship is grounded, while the stem and stern are in deep water. The reason is obvious: in such a case there is nothing to bear the strain but the keel, the planks, and lining. In fact, the ship receives a disposition to break from the moment she is launched; for the middle of the ship displaces a greater quantity of water, foot for foot of the keel, than either of the ends, and, of course, performs the office of a floating fulcrum, acted upon by the gravity of the ends. This evil cannot be removed while the present form is retained; but the ship may be strengthened in her structure, to enable her the better to resist that tendency.

A ship, as at present constructed, consists of the ribs, and of the inside and outside planks, the planks crossing the ribs, nearly at right angles. It is a three-fold structure, in which, using round numbers, the outside planks occupy ¼th, the ribs ½, and the inside planks ¼th of the thickness.

Now it might be demonstrated, were that necessary, that if the space now occupied by the ribs was supplied by a double row of planks, bent into the required curves, placed in the same order as the ribs, and so disposed that the joinings of each row respectively should be covered by the solid parts of the other, that then a stronger structure would be obtained than results from the present method of a single row of ribs. In adopting the method just mentioned, straight-grained planks of the greatest lengths might be used, and consequently the numerous scarvings and joinings of the present system, be almost entirely done away. The advantages to be hence derived, in point of strength, and the facility of obtaining proper materials, are obvious.

But though the above would be a great improvement, it falls infinitely short of the perfection to be obtained by employing the very same materials, in a still more scientific manner.

It has been already proposed to substitute two rows of bent planks for the present ribs: but there is no necessity that these should, as in the present system, be at right angles to to the outside planks and the lining. To obtain the greatest possible degree of strength from the same quantity of materials, the bent planks employed as substitutes for ribs, should cross each other at the keel, and consequently up the sides of the ship at such an angle as to form with each other, at the points of intersection, a kind of lozenge. By such an arrange-

ment, each row crossing the other at an angle, the one as it rises from the keel taking an angle forward, say of 50° to 55°,) and the other a like angle aft, they exert their strength in different directions, and the whole are made to act as a combination of so many diagonal spurs giving strength and solidity to the structure.

A slight examination will be sufficient to convince any person, habituated to investigating questions connected with the strength and economy of materials in scientific mechanism, that a ship so constructed must be, at least, twice as strong as one built according to the plan in common use. Nor is this all! When a ship of the common construction starts a plank, by labouring in a heavy sea, nine times out of ten she founders; but one built on this plan, in such an event, would still be a safe bottom; the crossing of the rib-planks preventing the admission of water in such quantity as to be beyond the power of moderate pumping to keep under.

To insist on the advantages in point of economy, and the diminished number of joinings, from being enabled to employ straight-grained planks, at all times to be obtained with comparative ease, and of considerable lengths, would be to insult those to whose consideration this *System of improved Ship-building* is submitted. Were this adopted, there would be no need to send persons abroad to buy timber; our own forests are sufficient to supply us with the straight timbers for 100 years to come, and at half of the expense, during which time more would be growing.

Method of manufacturing Iron and Steel Wire, free from the marks of the Pincers, and of rendering it perfectly straight.

The first step in manufacturing iron and steel wire, is to select iron of a proper quality. It should combine the highest degree of ductility, with tenacity, hardness, and susceptibility of a fine polish, and its goodness for the purpose can only be determined by experiment. To obtain it of a uniform quality, the proprietors of a large manufactory will always find their advantage in smelting their own metal.

The following details exhibit the management of one of the most considerable manufactories of iron-wire in France. This manufactory furnishes annually, in cards for wool-combing only, a hundred thousand quintals of iron-wire.

At this manufactory, when the iron is formed into an irregular bar, of about a centimetre ($\frac{4}{10}$ths of an inch) in diameter, they begin to draw it into wire. Although it be already much extended by hammering, it is in the first place passed four times through the drawing plate; then its particles, disposed lengthways, exhibit fibres at their utmost extension; the fibres are removed by means of heat which divides them, and after that the wire may again be reduced three numbers; the fibres which are re-produced by this operation are again removed by heat; the whole process is five times repeated; consequently the wire is passed through fifteen numbers, after which a single exposure to the fire is sufficient to fit it for passing six others, and then it is reduced to the thickness of a knitting-needle. The steel wire, being much harder, requires to be passed through forty-four numbers, and to be annealed every other time.

Thus far the wire is drawn with pincers or the bobbin; which latter (invented by the grandfather of the present proprietors) is a cylinder adapted to the axle-trees, and is used to avoid the marks made by the pincers.

The heat required for the wire must be regulated by its diameter, according to which the caloric penetrates more or less rapidly to the centre. Besides, when it is sufficiently stretched, each thickness exhibits a peculiar colour, which the workman is careful to observe.

If the heat be not sufficient, the change of the mechanical state of the particles of the iron will not be effected; that is

to say, they will preserve the situation and appearance which they have after being passed for the first time through the drawing plate; they will be stretched to the utmost extreme; their aggregation will be destroyed, in bringing the wire to the usual smallness: it will break every instant, and it will not afterwards be possible to restore its pliancy by the means of heat, because the dispersed particles cannot be influenced by it.

The contrary cause will produce the same ill consequences; for if the heat be too powerful, the particles will be too much disunited to resist the tension they must necessarily undergo in the course of drawing the wire, which will therefore be constantly breaking.

In order to anneal the wire, a large and elevated furnace is employed; bars of cast-iron support the wire in the middle of the flames.

It contains seven thousand pounds' weight, so contrived as to contain equal portions to each number. They are so arranged that the thickest wires receive the strongest heat; in order that the whole may be equally heated in the same space of time. The operation lasts three hours, with a fire well kept up: and it might be imagined that this apparatus was completely adapted to the purpose; but it has the imperfection of leaving the wire exposed to the contact of the atmospheric air, the oxygen of which fastens on it with extreme avidity; whence a considerable loss is occasioned by the oxide, and also an expensive operation to free it from the defect, which consists in heating the bundles of wire with a wooden hammer wetted with water. Notwithstanding this precaution, there often remains a portion of oxide adhering to the surface of the metal: it streaks the drawing iron, fixes on the wire, gives it a tarnished appearance, and causes it to break when it is brought to a certain fineness.

The proprietors have long sought to remedy these inconveniences, and have at length invented another furnace, (see plate XL.) It is round, and is about one metre six decimetres (63 inches) in diameter, and one metre eight decimetres ($70\frac{8}{10}$ inches) in height, without including its parabolic arch, (which produces a reverberation of the heat,) and the chimney above it. The interior is divided by grates into three parts; the first, *b*, fig. 1, receives the cinders; the second, *c c*, is the fire-place; and the third space, into which they slide a roll of wire, weighing a hundred and fifty kilogrammes, (400*lbs.* troy,) which is inclosed in the space *g g* (comprised between two hollow cast-

iron cylinders ;) so that the flames circulate about the first *f f*, and within the interior of the second *e*, which defends the wire from the atmospheric air. The diameter of the largest cylinder is about one metre four decimetres (55 inches); that of the second one metre ($39\frac{3}{10}$ inches); thus the space comprised between them is two decimetres, on an elevation of five decimetres. There must be several pairs of cylinders provided; because, whilst one pair is in the furnace, another must be prepared to receive a fresh roll of wire. They are changed every hour by means of a long iron lever *u u*, with which a single man can easily push them in and draw them out again.

They are very careful not to open the cylinders immediately on their being drawn out of the fire; for the rolls of wire contained in them, being still red, would oxidate almost as much as if they had been heated in the midst of the flames without the least precaution.

The opening contrived for the passage is on the side, and has a door of cast-iron *o*, with a groove which winds round the furnace; the fire-place has one something similar to it; that of the ash-hole is vertical, in order that it may be raised to increase the fire at will.

a a a a, is a section of the furnace with its chimney; *b*, the ash-hole; *c c*, the fire-place; *d*, the door of the fire-place, placed opposite to that of the ash-hole; *e*, the interior of the small cylinder; *f f*, the external sides of the large cylinder; *g g*, the space between the two cylinders which contains the iron wire; *h*, the opening which facilitates the passage of the air and flame; *i i i i*, the edges of the platform, which are luted to prevent the admission of air between the two cylinders; *k*, the inner opening for the passage of the flame into the cylinder, and is larger than the upper orifice *h*; *l*, a hook that serves to draw the cylinders out of the furnace, and forms a part of the platform; *m m*, section of the opening made for the admission of the cylinders; *n n n n*, circular grooves for the door of the said opening; *o*, section of the door: *p p*, the grate that supports the platform: *q q*, the cast-iron surface on which the cylinder slides; *r*, the cylinder drawn out of the furnace; *s*, the chain with which it is drawn out; *t*, the capstan; *u u*, the lever; *v v*, teeth that support the lever.

Fig. 2, a horizontal view of the cylinder fixed to the platform.

This detail is sufficient to show the advantages of this furnace. It is certainly more expensive to maintain than

the other, but its advantages are more than an indemnification.

A smaller furnace is employed for all the wire intended for cards, and they only use the larger one for steel wire, or a hard kind of iron which they have found to be not so easily attacked by oxygen. In order to diminish the waste that the great furnace might occasion, they have contrived a new process, which consists in dipping the bundles of wire into a basin of wet clay, when they put them into the furnace; and there they are left to dry before the fire is lighted, without which precaution the clay will peel off before the iron is cool.

It is unnecessary to enter into further details with respect to the operation of annealing.

They use two sorts of drawing plates, large and small ones; the first for the sort of wire that we have been describing, and the latter for such as may be done by hand, and to which we shall presently attend. The steel employed for these drawing-plates, should never vary in quality: except that such as is intended for the smaller plates, is made the finest; as for the other plates, the method of preparing them is the same as for other articles.

Several pieces of iron are disposed in the furnace in the form of a box without a lid, their weight being according to the use they are intended to be employed in. The workman fills each of these boxes with cast steel; having covered it over with a luting of clay, it is exposed to a fierce, fire until the steel be melted. His art consists in seizing the proper moment to withdraw the plate from the fire; he raises the luting, and blows on it through a tube in order to drive off all heterogenous parts, and then amalgamates it with the iron by light blows. After it is cool, he replaces it at the fire where the fusion again takes place but to a less degree than before; he afterwards works the steel with light blows of the hammer, to purify and solder it with the iron. This operation is repeated from seven to ten times, according to its quality, which renders it more or less difficult to manage. During this process a crust forms on the steel, which is detached from it the fifth time of its exposure to the fire, because this crust is composed of an oxidized steel of an inferior quality. It sometimes happens that two and even three of these crusts are formed, of about two millimetres in diameter, which must also be removed.

After all these different fusions, the plate is beaten by a hammer, wetted with water, and the proper length, breadth, and thickness, is given to it.

When thus prepared, the plates are heated again, in order to be pierced with holes by punches of a conical form; the operation is repeated five or six times, and the punches used each time are progressively smaller. It is of importance that the plate never be heated beyond a cherry red, because if it receive a higher degree of heat, the steel undergoes an unfavourable change. The plates, when finished, present a very hard material, which nevertheless will yield to the strokes of the punches and the hammer, which they require when the holes become too much enlarged by the frequent passing of the wire through them.

It is to be observed, that when the plates have been repaired several times they acquire a degree of hardness, which renders it necessary to anneal them again, especially when they pass from one size to another: frequently they do not acquire the proper quality until they have been annealed several times.

Notwithstanding all the precautions taken in preparing the plates, the steel still varies a little in hardness; and according to this variation they are employed for drawing either steel or iron wire; but if the workman who proves them, finds that they are too soft for either one or the other, they are put aside, to be used by the brass wire-drawers.

A plate that is best adapted to drawing steel wire, is often unfit for the iron; for the long pieces of this latter metal will become smaller at the extremity than at the beginning, because the wire, as it is drawn through the plate, is insensibly heated, and the adhering parts are swelled, consequently become inflated, and the wire is more strongly pressed and reduced in size towards the latter end.'

The plates that are fit for brass, are often too soft for iron, and the effect resulting is the reverse of that produced by a plate that is too hard.

The smallest plates are at the least five-twelfths of an inch in thickness; so that the holes can be made sufficiently deep; for when not so, they seize the wire too suddenly and injure it. This inconvenience is much felt in manufactories where they use the plates for too long a time, as they become exceedingly thin after frequent repairs.

We left the iron wire at the thickness of a knitting needle; in this state it is put, in bundles of 125 kilogrammes each, into

a large vessel, in order to prepare it to be reduced for the last time. This vessel is placed upside down in the middle of a round furnace, which is so constructed as to sustain burning coals all round it, and of which it consumes 35 kilogrammes before the operation is completed.

The cover must be carefully luted, as the slightest admission of air is sufficient to burn the upper surfaces of the wire, which cannot afterwards be reduced.

When one of these vessels is replaced by another, it is suspended over the flames of the furnace; being previously filled with water, containing three kilogrammes of tartar.

This solution, without attacking the metal, frees it from the grease and the little oxide that adheres to it.

This operation is the last in which the wire is exposed to the fire; as it is then in the proper state for being reduced to the degree of fineness it is capable of sustaining, and preserves enough of the effect of the annealing, to require it no more; yet when the natural hardness of the iron varies, this last exposure to the fire should take place in proportion to its thickness: thus as steel loses its capacity of extension much sooner than iron, it is annealed until it is no thicker than a sewing needle. The space which this leaves in the vessel is filled up with charcoal dust, which prevents it from losing the quality of steel, and preserves the heat long enough to give it the proper degree of pliancy.

As the proprietors always use iron and steel of the same manufactory, they have been able to reduce their operations to a general system; to attain this end, they had only to find a graduated scale, by which the wire would not be more stretched in the drawing plate, in one number or size than in another. The following is the method they have contrived, in order to form this scale for the iron wire: it was found necessary to employ another for steel wire.

They take a certain quantity of various thicknesses, which has been drawn as fine as the iron would bear; (the smallest size is 100,000 metres in length to the kilogramme;) they note the weight that each might be capable of supporting without breaking; this being expressed by figures, it is easy, by a few changes in their differences, to express them in a progressive form,* from which gauges or calibres may be made, that may be put into the hands of the workmen; these guages are

* This kind of scale has been partly formed, by comparing the weight of the sizes with equal lengths.

certain guides, which they cannot mistake, except through great carelessness. If they had not these guides, they would often pass the wire through holes in the drawing-plate that are too large for it, whence it does not acquire the strength it should have in proportion to its thickness, and consequently loses its hardness. They would also be likely to pass it through holes that were too small, which weakens and renders it very brittle. In the latter case it frequently happens that the steel of the drawing-plate, being unable to sustain the force to which it is exposed, will give way, as if the plate were too soft; and the wire will be brittle at the beginning, and soft and too thick at the other extremity.

The greatest part of the fine wire of this manufactory, is drawn by workmen who are dispersed about the country. These men have a staple in three of the principal villages, where every week they deliver up the wire they have drawn, and receive a fresh supply, and where their work is examined with the greatest accuracy.

As it was not possible to accommodate all these wire-drawers in one place, the proprietors were long desirous of bringing a certain number of them into their immediate neighbourhood, in order that they might be at hand to afford a daily supply to the establishment. One of their hydraulic wheels was appropriated to the execution of this project; and they have established a machine which moves 24 bobbins in a horizontal direction, which only requires the workman to look after the wire. The time that is saved enables him to employ two bobbins at the same time, instead of one; and the price of manual labour is thus diminished nearly one-half.

It is upon the bobbins that the wire is reduced to the different sizes desired; therefore this is the last operation in the art of making iron and steel wire. Yet although it has all the requisite qualities given to it in the workshop of the wire-drawer, it is still incapable of being made into needles, and especially carding-hooks; it has still to undergo an operation which is considered the most difficult and delicate of all; this is the dressage or straightening, by which it is made to lose the bend or curve that it acquires on the bobbins.

This work consists in passing the wire between nails implanted on a piece of wood, and which act against it as so many little vices, the last of which tends to force it into a straight line. For this effect the dresser is obliged to be constantly adjusting the nails, by inclining or raising them

with the strokes of the hammer. It is requisite, that each number be at different and calculated distances. It may be easily imagined that this department requires a workman of intelligence, diligence, and address; but it is impossible for him to succeed entirely. Being convinced of this truth, the proprietors have avoided it, by the invention of an instrument appropriated to this operation,—(see plate XL, fig. 3.) Six little puppets of very hard steel, *c c c c*, are substituted for the nails of the ordinary instrument, and are fixed on the parallel bars *b b b*, which are widened or brought nearer together by screws. A scale, *m*, sustained by a screw, indicates the distance that the puppets should be from each other to straighten each size. Thus all difficulties are adjusted by an invariable rule; and the dresser (who may be a child) saves a third of the time which is employed in regulating the instrument formerly used. There is nothing more to be done but to draw out the wire by means of a wheel, on which he divides it, and then forms it into bundles to be delivered to the consumers.

At a little distance from the end of the puppets, there may be placed at pleasure a light weight, which depresses the beginning of the wire, and which is passed over an index that shows its degree of flexibility.

EXPLANATION OF THE PLATE.

Fig. 3, a front view of the machine for straightening iron and steel wire intended for needles and carding hooks.

a a a a, The piece of copper to which the machine is attached.

b b b b, Bars, the movement of which is parallel.

c c c c c, Moveable puppets with their bars.

d d d d, Supports of the puppets, with a screw to advance or draw them back when in use.

e e, Moveable supports round an axis.

f f, Bars which form a part of the supports.

g g g, Nails which maintain these bars in the proper position, yet without preventing them from following the movement of the parallel bars, so that they shall cross the two last puppets according to the thickness of the wire (these puppets break the sinuosities of the wire.)

h, Conductor of the wire to the puppets.

i, Another conductor which serves to prevent the wire from being shaken.

k k, Slides which serve to determine the position of the bars *f f*.

l l, The screw with its nut.

m, Scale which is attached to the screw, and indicates the distance of the puppets for each number or size.

n n, The iron wire.

Fig. 4, side view of the same machine; *o o o o o o*, grooves at the extremity of the puppets to give a passage to the wire; *p p p p p p*, screws to press on the puppets; *q q q q q q*, screws which pass through the grooves *r r*, of the plate *a a a a*, fig. 3; *s*, a fixed screw.

Fig. 5, a front view of the instrument to determine the suppleness of the wire; it is occasionally added to the end of the machine fig. 3; *a* the screw which raises and lowers a little weight *c*, which is suspended to the wire *b*; *d*, a groove in which the weight runs; *e*, the scale; *f*, a slide to hold the wire according to its number; *g g*, the numbers of the wire under trial, pressed upon by the weight *c*.

The rough steel employed by the proprietors, is brought from one of the best iron-makers in France; its price is moderate; but if they wish it to possess all the qualities of foreign steel, they procure it in bars, which are equally good and the same price as what is produced in the neighbouring states.

The steel of France is also proper for many purposes; it is bought from this manufactory for making knitting-needles in the English fashion, shoemakers' needles, and other similar articles. It may also be used for needles of all sizes, and even for cards for wool-combing; but as this steel is much more expensive than the iron wire, it is very seldom used for the latter purpose.

The proprietors have added six kinds of steel to the collection of specimens of iron wire, which they presented to the Society of Encouragement, and which are considered as the best in quality, but at the same time the most difficult to work. They have rendered them almost as ductile as iron, without altering the quality.

Although the Authors have united the steel to the iron wire in their account of the manner of treating it, they nevertheless manufacture each at different establishments, placed on the same course of water, at the distance of about 110 yards from each other; they have for each purpose distinct workshops established in a large way.

One of them is a forge to reduce into irregular bars the steel and iron of Normandy, which arrives in large pieces.

The separation of these two establishments procures to the proprietors the advantage of allowing the hydraulic machine that draws the steel wire, to go slower than those which draw the iron; for the first, as very hard, offering more resistance to the drawing-plate, should be pulled out with more care, since the quickness ought to be proportionate to the resistance, and reciprocally; for if they depart from this principle, the results will vary: thus, for example, the iron of the department de l'Orne, which is more compact than that produced at another establishment of the proprietors, situated at Haute Saone, drawn by the same machines, augments in hardness, and is weakened, when it is brought to too great a degree of fineness. But the iron produced at the first-mentioned place, which is very hard, and capable of receiving a very high polish, is to be preferred for certain uses, so that as ready a market is found for it as for the softest iron.

The original of the preceding memoir is accompanied by a great number of certificates from artists and manufacturers, who employ the iron and steel wire made according to these processes, and the good quality of which they attest.

It may be interesting to the English manufacturer to be acquainted with the prices at which the best qualities of iron-wire can be afforded in France. A table is therefore subjoined of the prices of the different numbers or sizes manufactured at the establishment we have been describing; and with respect to the weights and money, we may observe that,

1 kilogramme is equal to about $2\frac{6}{10}$ pounds troy.
1 franc is equal to 10d.
100 centimes make 1 franc.

Mouchel's improved method of drawing iron and steel wire.

PRICES OF IRON AND STEEL WIRE.

Thick wire of Normandy, without the mark of the pincers.

In bundles of five kilogrammes.

No.		Francs.	Centimes.
1	at	10	55
2 & 3	.	10	10
4	.	9	30
5	.	8	45
6	.	8	20
7	.	8	—
8	.	7	60
9 & 10	.	7	45
12 14	.	7	25
15 18	.	6	90
the rest	.	6	70

Steel wire.

By the kilogramme.

No.		Francs.	Cts.
0	at	5	—
1	.	4	60
2	.	4	35
3	.	4	20
4	.	3	95
5	.	3	75
6	.	3	50
7	.	3	40
8	.	3	30
9	.	3	20
10	.	3	10
11	.	3	5
12	.	3	—
13	.	2	95
14	.	2	90
15	.	2	85

Wire for cards.

In bundles of one kilogramme.

No.		Francs.	Cts.
5 & 6	t	2	20
7	.	2	25
8	.	2	30
9	.	2	35
10	.	2	40
12	.	2	45
14	.	2	55
16	.	2	75
18	.	3	10
20	.	3	20
22	.	3	60
24	.	4	25
26	.	6	15

Wire for general purposes.

In bundles of five kilogrammes.

No.		Francs.	Cts.
8	at	10	95
9	.	11	15
10	.	11	35
12	.	11	75
14	.	12	20
16	.	13	—
18	.	13	84
20	.	14	67
22	.	16	30
24	.	19	60
26	.	25	35
28	.	32	70
30	.	49	30

Method of preventing Workmen from being injured by the escape of small particles of Iron or Stone, in the dry grinding or pointing of Needles.

The operation of pointing needles, is performed on a grindstone perfectly dry. In consequence, therefore, of not using water, or some other fluid, the particles of stone and steel which are separated by the attrition, and which are extremely fine, are dissipated through the surrounding air. Hence the workmen draw them in with their breath;—at first the mischief is not perceptible, and the men are generally allured to persevere, by the high wages they receive, until their health is irremediably injured. In a shorter or longer time, often in two or three years, a pulmonary consumption terminates their existence. Dr. Beddoes asserts, that the lungs of men who have thus suffered, have, on dissection, been found covered with tubercles containing particles of steel; thus evidently indicating the cause of their death. The Society for the Encouragement of Arts, &c. aware of the injurious nature of the usual mode of pointing needles, offered a reward to the inventor of the means of lessening or removing the evil. This offer brought forward an invention, the adoption of which would certainly be productive of considerable benefit. It requires the gteater part of the grindstone to be covered by a case, a pane of glass is employed to see through, and a wet cloth is applied so as to intercept a considerable proportion of the fine particles of steel and stone which are separated. To render this invention the most effectual, there is a demand upon the attention of the men: they must keep the cloth wet, and they have occasionally to clear it from the particles it has collected. But as in cases where the mischief of remissness is not very apparent remissness may always be expected, it is desirable that such attention should be rendered unnecessary, and that the means of preventing the evil in question should be constant in its action, and inseparable from the use of the machinery. These requisites are combined in the method of dry grinding proposed in this article.

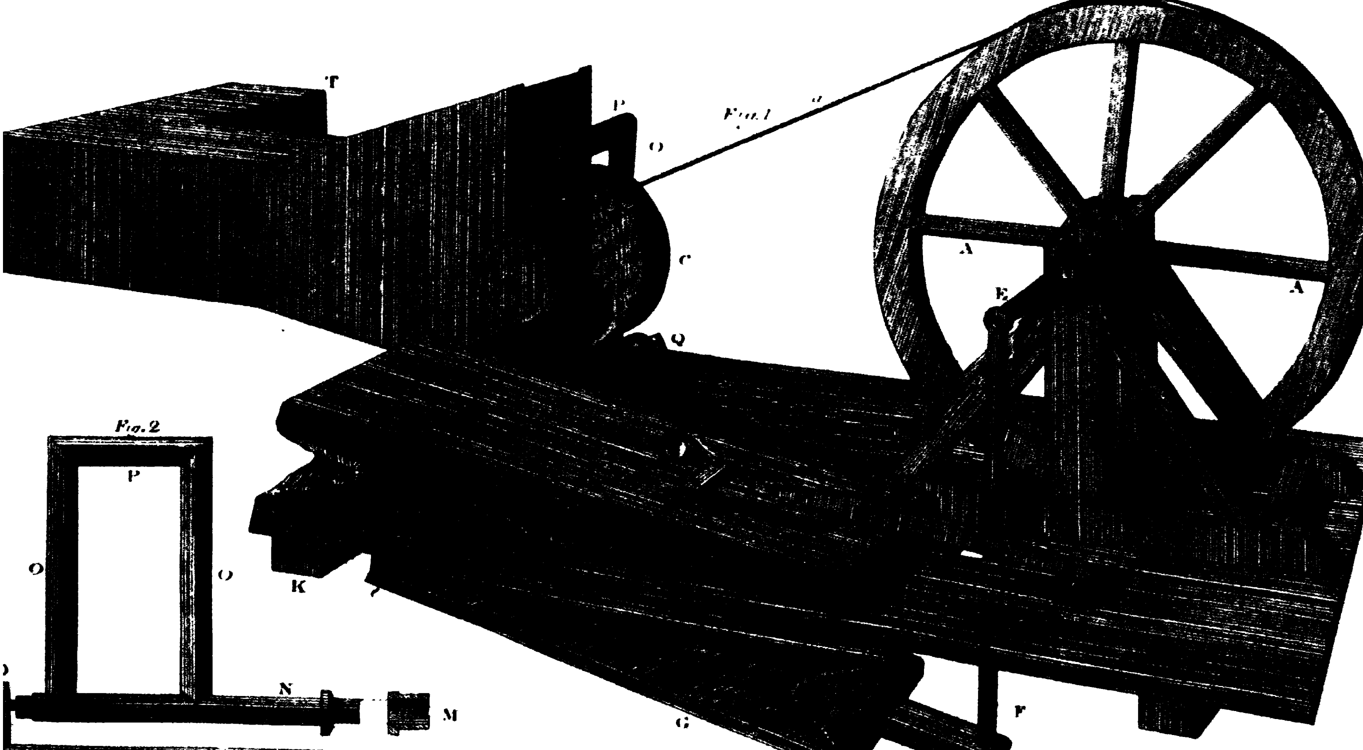
This contrivance consists of a conical box or case, inclosing nearly one half of the grindstone, to receive the dust of steel and stone, made in the operation of dry grinding; the

dust being caused to enter the box by a current of air produced by a pair of bellows. The needle grinding mills are generally very extensive buildings, with numerous apartments, each containing many grindstones for pointing needles, all which are driven by one powerful water-wheel, or other first mover, and the bellows which are employed in the present plan, might be made large enough to supply all the grindstones contained in one room, or even one wing of the mill.

AA, fig. 1, plate XLI, represents a large wheel, giving motion to the grindstone by a band *a* passing round a pulley B, fixed on the axis or spindle of the grindstone C, (which is supported in the usual manner, though not here shown.) The great wheel is represented in the figure as if mounted in a frame DD, to be turned by a handle, on the opposite end of the spindle, in the same manner as the wheels used for turning lathes or cutlers' grindstones; but in the needle-mills, this large wheel is part of the mill, and is generally situated beneath the floor of the room in which the grindstones are placed, being fixed on a long horizontal shaft, which carries several such wheels, each giving motion to one grindstone. Upon the end, or any other convenient part of this shaft, a crank E is fixed, which by means of a rod F, gives motion to a pair of double bellows G, constructed and acting in the same manner, as those used for organs, being contrived to keep up a constant and regular supply of air.

The bellows consist of two distinct parts, G and H; the lower one is the feeder, and throws the air into the upper one H, which is the regulator, to equalize the current of air, and make it constant. The feeder G, consists of two boards; the upper one, *f f*, is fixed, and the lower one, *e e*, moveable on hinges at its joint, by means of the rod F, as before described. It is connected with the upper board by leather, surrounding all its sides, and neatly folded. In the lower board *e e* is an aperture, covered by a valve, (called by the organ-builders a pallet,) opening inwards to permit the entrance of the air, but to prevent its return. Through the upper board *f f*, is another opening, with a valve shutting downwards, through this the air passes into the regulator H, which is also made with two boards connected by hinges and leather, in the same manner as the feeder. From the regulator the air passes off to the grindstones by a trunk K, extending along the whole length of the mill immediately beneath the floor.

— [illegible] Machine to carry off the dust produced in Pointing Needles



Prior's method of preventing the injurious effects of dry grinding.

When the lower board *e e* of the feeder is depressed by the motion of the crank E and the rod F, the chamber of the feeder is enlarged, and the external air opening the valve in the board *e e*, fills the cavity. When the board is lifted up, this valve closes, and the contained air is forced through the valve in the board *f* into the regulator, the repetition of which motion keeps a constant supply of air in the regulator. The top board *d d* of this is loaded with weights, which, resting upon the included air, forces it out from the regulator, in an equable stream, through the trunk K, and from that to every grindstone in the mill.

NOOP, is an assemblage of tin pipes, which surround the grindstone, and have openings in the fronts of them, through which the air issues to carry off the dust. This is shown separately at fig. 2, where M represents a brass socket, which is supposed to be fixed to the floor, and by means of a small pipe communicates with the wind trunk K; into this the end of the pipe N is fitted, and the other end of it being supported by the point of a screw Q, it turns on this as a centre: the two pipes OO are soldered into this at right angles, and are united at the top by the short pipe P: in these pipes small slits or crevices are made, as shown by the dark lines, through which the air issues, and blowing towards the grindstone, carries off the particles of dust into the trunk R, fig. 1, which may be continued forwards at S, through the wall of the building into the open air: or, if it is turned sideways, as at T, all the trunks R of the other grindstones, may be carried into it, which will succeed better, because the whole body of air being thus carried through one common trunk, and being thrown out into the open air in one place, will have the greater force to carry the dust with it.

I is a safety-valve, covering an opening in the top of the upper board *d d*, of the regulator: it is kept shut by a wire spring, and has a wooden handle or tail L, by which it may be lifted up. When the board of the regulator rises as high as is intended, this tail comes in contact with a piece of wood, and thus opens the valve, permitting the air to escape; by which means there is no danger of the bellows being burst, for this valve is always opened when the regulator becomes full, so as to be in any danger of a rupture.

The pipes OOP, as before mentioned, turning on a centre, they can be removed nearer to the grindstone at pleasure, as it becomes reduced in diameter by wearing away.

It is not necessary to remove the large particles of sand,

which are heavy enough to fall to the ground; but only those which are so light as to float in the air, and which in the act of breathing, are in the common mode drawn into the lungs, producing many disorders, and in a very few years proving fatal to the operators.

In grinding the needles, the points must be laid on the grindstone. as nearly under that part of the tube which goes over the top of the stone as convenient; for which purpose the tube is made to move backwards and forwards, so as to approach the part of the grindstone employed by the workmen.

There is a great advantage arising from blowing the air out of the room, as any stagnation of air is thus prevented, and the whole quantity being blown out in a very few minutes, there will always be a renewal of fresh air, which will be very salutary to the workmen, particularly if confined in a small apartment.

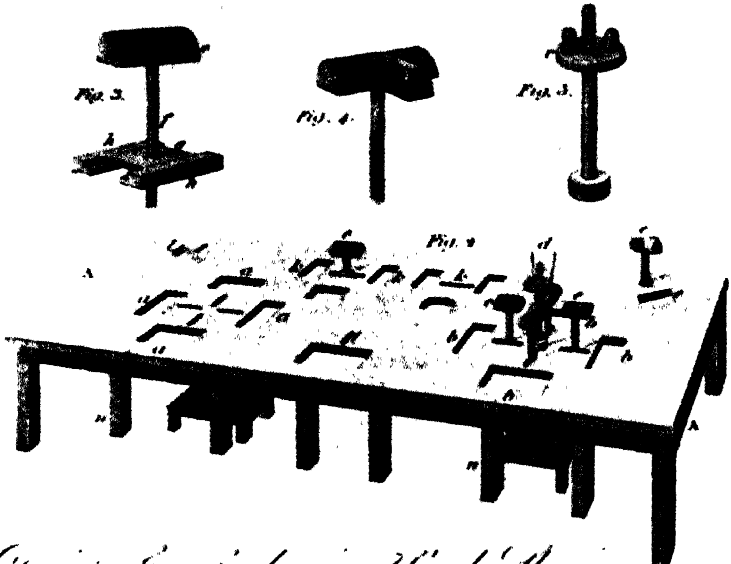
A safe and economical mode of burning the Shavings in Workshops, and converting the Heat to useful purposes.

The object of this contrivance, which is represented by fig. 1, plate XLII, is to employ shavings of wood instead of coal as fuel, by such a construction of the stove that they will not blaze away too fast, as they do in an open fire, making a strong heat, but only of a momentary duration. This is effected by putting the shavings into a sheet-iron cylinder, closed at the top, which is fitted into the top of a stove, very similar to those always used in such situations for burning coals; and the flame produced by the shavings passes through flues conducted in the usual manner; the air which supports the combustion being supplied through the bars of the grate.

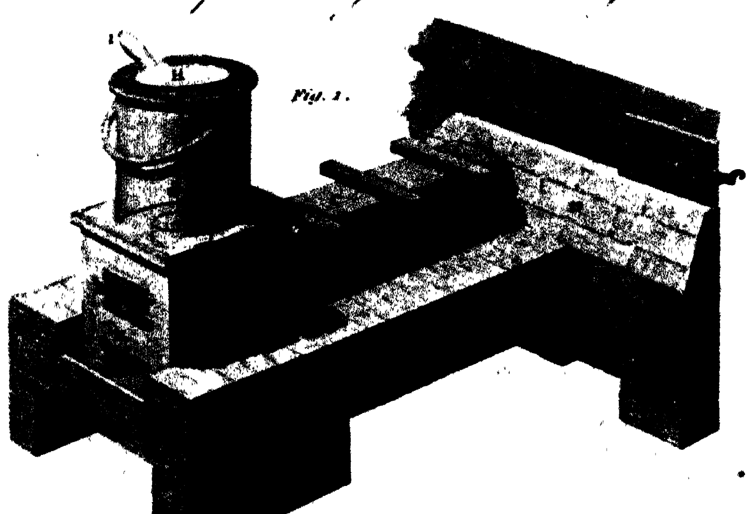
AA, represents part of the interior wall of the workshop where the stove is placed.

B, the stove, which is made twelve inches wide, and fifteen inches high: it is of cast iron, and lined with fire tiles,

Barralet's Shop-board for Tailors



Davis's Stove for burning Wood Shavings.



Lowry sculp.

Published by Henry Fisher. Caxton. London. 1823

having a door or fire-grate, with an ash pit beneath, in the usual manner.

C, is the sheet-iron pipe, six inches wide and four inches deep, which conveys the smoke and flame from the stove into the brick flue at D, and this leads into the chimney at E.

F, is an iron door opening into the chimney, for the sweeping machine, or boy, to pass through, to sweep the chimney.

G, the sheet-iron cylinder, in which the shavings are put to be consumed, which is about nine inches in diameter, and sixteen inches high: it is placed over a circular aperture in the top of the stove B, and has a neck (shown by the dotted lines) to fit the hole in the top of the stove, to prevent the sparks of the shavings from flying out into the workshop.

The cylinder G is covered at the top with a lid H, having also a neck, which is removed at pleasure by its handle I, to put in a supply of shavings: this fits very close, and as no air can pass by it, a sufficient draught to burn the shavings, but slowly, is afforded by the air passing through the bars of the grate, which is impeded by the ashes which may be there: but this flame may be increased to a rapid combustion when necessary, by opening the door of the stove; the flame passes along the flues C and D, and gives out an equable heat to the room. Iron bearers are fixed across the flue D, which may be used to support work requiring to be dried, or for any similar purpose.

The supply of this stove with fuel from shavings, is attended with so little trouble, and is such an advantage to the workmen, that they will always prefer burning that fuel to coals; insomuch that where ten men are at work, there is a difficulty to collect shavings sufficient to light the fire the next morning.

By this means the danger of fire which has been fatal to so many manufactories, is greatly lessened; the loose shavings being consumed as soon as they are made, and that in lieu of a more expensive fuel; and so slowly are the shavings consumed, that the iron cylinder will hold enough, when crammed full, to supply the fire upwards of half an hour.

To guard workshops still more effectually from danger, the stove and its iron flue are supported on a mass of brick-work, which prevents any sparks, &c. from falling upon the floor; and the sides of the brick-work afford very convenient shelves on which to lay veneers and other work requiring to be heated, dried, &c.; and when a great heat is required, to extend to a considerable length horizontally, as, for instance,

four or five feet, by merely putting a few shaving into the cylinder frequently, instead of filling it, they become converted into flame, which is carried the whole length of the iron flue, heating it uniformly throughout. No soot lodges in the flue, but merely light ashes, which can easily be cleared out from time to time as may be necessary.

Before the Inventor adopted this mode of consuming shavings, his men, in the winter season, could not have the veneers, cauls, &c. ready in the workshop, in a proper state to be put together, till the middle of the day, and which can now be done in one hour; and in the evening it was necessary to make a very large coal fire at the time the men were leaving work, that being the time they generally completed their largest glueings for the day, in order that they might have the advantage of the night to set the work, to be ready the next morning to clean off: but they can now complete their work as they go on. If cinders or ashes be mixed with the shavings, the fire will burn, though not so briskly, for several hours; and a little more attention will be required than with shavings alone, to prevent smoking, by keeping the pipe clear, and putting in small quantities of fuel at a time.

Description of a Hydro-pneumatic Blow-pipe for the use of Chemists, Enamellers, Assayers, and Glass-blowers.

This invention consists of a tin box, with a partition in it reaching from the top at one end to within an inch of the bottom. The vessel is air-tight at this end. It is three parts filled with water. If by means of a tube reaching within half an inch of the bottom, the water is blown into at the air-tight end, the air rises in bubbles through the water to the top, and forces the water under the partition into the other compartment. The weight of the water acts upon the air which had been blown in, and forces it through a blow-pipe directed to the lamp, and keeps up a continued blast till the air is exhausted. More air may be blown in from time to time, so as to keep the blast regular and continual. The inventor constantly uses this instrument for his fancy-glass blowing. The whole appa-

ratus, including lamp and case, weighs only three pounds and a half; and it can be furnished complete for £2. 12s. 6d, made of tinned copper.

The utility of the blow-pipe in the arts, to raise a great heat in a small object, from the flame of a lamp, is too well known to require pointing out. The assay of minerals, the arts of enamelling, jewellery, soldering metal works, but above all, the blowing of small articles in glass, are purposes to which it is better adapted than almost any other mode of applying heat. The usual manner of producing a stream of air for blowing glass, is by means of a small pair of double acting bellows, fixed beneath a table, and worked by the operator's foot; a pipe proceeds from these bellows to the top of the table, and terminates in a small jet, before which a lamp is placed, and the flame blown by the current of air upon the object to be heated. The defects of the bellows are, that the stream of air is not perfectly regular, which causes a wavering of the flame, so that it does not fall steadily upon the object which is to be heated. In the hydro-pneumatic blow-pipe, these defects are corrected, by using the pressure of a column of water to regulate the stream of air, and the supply is furnished from the mouth of the operator, by occasionally blowing through a tube.

Plate XXXVII, fig. 4, exhibits a section of this instrument, and fig. 5, a perspective view of it in action.

AA, is a vessel of tinned iron or copper, about 17 inches high, 5 wide, and 9 broad; the lid of which opens and shuts on hinges, and supports the lamp B, which burns tallow instead of oil.

C is the blowing pipe, by which the air is thrown into the vessel AA. This vessel, as is shown in the section, fig. 4, has an inclined partition D, which divides it into two chambers, E and F; but as the partition does not reach to the bottom of the vessel, the two compartments communicate with each other underneath it: that marked F is closed at the top, so as to be air-tight, but the other is only covered by the lid of the vessel, and may therefore be considered as being open to the outward air. The pipe C, fig. 4, is soldered air-tight, where it passes through the top of the chamber, and descends very nearly to the bottom of the vessel, deeper than the partition D does, so that its mouth is always immersed beneath the water. The metallic part of the blow-pipe G, which conveys the blast of air to the flame of the lamp, is likewise soldered into the top of the chamber F;

it holds a bent glass tube, *a*, which terminates in a very small and delicate jet, and is fitted air-tight into the tin or copper tube G.

By blowing into the tube C, the air is forced out at the bottom of it, and rises in bubbles through the water into the upper part of the chamber F; this displaces a corresponding quantity of water, which passes under the partition D, into the chamber E, elevating the surface of the column of water, and depressing the other, as shown in the figure; the water, endeavouring to return to its original level, causes a constant compressure of the air, and forces it through the jet *a*, into the flame of the lamp. By this means, it is not necessary to low constantly with the mouth; for though the air is forced into the receiver at intervals, yet the pressure of the water will expel it in a constant stream, and the operator will not be fatigued by the motion of the foot, necessary in working bellows, nor need even to keep his mouth at the pipe constantly, but merely to blow from time to time, as he finds the stream of air to decrease in its power.

The metal socket which connects the glass tube or blow-pipe *a* with the vessel A, is made conical, and the tube, having a piece of paper first wrapped round it, is bound round with cotton-wick yarn in a conical form, so as to fit the socket tight, and yet permit the tube to be moved in any required direction, to cause the air to act properly upon the flame; and the curved metal tube C is also fixed into the upper part of the tube CC in the same manner.

HH are the two sides of a tin frame, which is fixed in front of the vessel; each side contains a groove, facing that of the other, to receive a tin-plate I, which forms a screen, and can be adjusted in height so as to keep the light of the lamp from the operator's eyes, though he can see the work over the top of it: this screen is held fast by its foot, being placed between the lid of the vessel and the top of the close chamber F.

K is one of two handles, which support the operator's arms whilst holding a glass tube or other matter in the flame, and there is another like it at the opposite side of the vessel: these handles are also wrapped round with woollen list or leather, so as to form cushions; and the vessel is steadily fixed upon a chair, bench, &c. by means of a leather strap buckled to the loops on each side of it, and passing under the chair, &c.

The lamp is made of tin, is of an elliptical, or rather of a bean or kidney shape, one side being curved inwards; across the centre of it stands a metal wick-holder, having a loop on

Tilley's hydro-pneumatic blow-pipe.

one side of it, and which is soldered to its bottom, (see *r*, fig. 6.) Through this loop the wick of cotton is drawn, and being opened both ways, as shown in that fig. and still plainer in fig. 8, forms a passage in its middle, through which the current of air from the jet *a* passes, as in figs. 4 and 8, and carries the long pointed flame upon the object to be heated.

The lamp, figs. 6 and 8, is filled with tallow; which melting by the heat, becomes sufficiently fluid to burn as well as oil, but with a less offensive smell, and when cold, it is, from being solid, more conveniently carried than oil. This lamp is placed within another vessel marked B, figs. 4, 5, and 8, which supports it at a proper height, leaving a space between them all round, to receive any tallow which may run over the interior vessel or lamp.

In using this blowpipe, the following observations being attended to, will greatly increase its effect. The long flat cotton wick of the lamp will be found to act better than the usual round cotton wick; but in either case the flame which it raises will be considerable. The end of the glass pipe *a* must be just entered into the flame, and the current of air will throw out a cone of flame from the opposite side. If it is well managed, this cone will be distinct and well defined, and extend to a considerable length. Care must be taken that the stream of air does not strike against any part of the wick, as it would then be disturbed, and the cone split into several parts, A wire bent at its end, as shown at fig. 7, is very convenient to smooth the passage through the wick. The jet of air must be delivered somewhat above the wick; and as, unless the flame was considerable, there would not be sufficient for the stream of air to act upon, for this reason the wick is opened, as shown in fig. 6, that it may expose the largest surface, and produce the greatest flame; the stream of air from the pipe should be directed through the channel or opening in the wick, so as to produce a cone the most perfect and brilliant. On examining this cone of flame, it appears to be formed of two different colours, the part nearest the lamp being of a yellowish white, and that beyond of a blue or purple colour.

The subject which is to be heated, is held in the flame, at the termination of the yellowish-white flame, where it receives the greatest heat, and is not discoloured by the soot which accompanies the white flame.

Tilley's hydro-pneumatic blowpipe.

A glass tube, when applied to this flame, is quickly rendered pliable, and may be bent or drawn out into threads or points, and hermetically sealed; or, by blowing into the other end of the tube, it may be expanded into a small globe, so as to form various small articles at the pleasure of the operator.

In chemistry, mineralogy, and the arts, the blowpipe is an extremely useful instrument, being capable of throwing such a powerful heat on a small object, as would be difficult to obtain on a larger quantity of the same substance, in the most powerful furnaces; and with this advantage, that the process is always under the inspection of the operator: whereas he can only conjecture what passes in the centre of a furnace.

In using the blowpipe for experiment, a piece of charcoal is generally used to support the subject, and held in the flame of the lamp; the charcoal should be of a close compact grain, and properly burnt; for if it be too little carbonized, it will flame like a piece of wood, and obscure the object; and if it is too much burnt, it is so quickly reduced to ashes, that the object is in danger of being lost in it. The charcoal greatly increases the heat, by reverberating the flame, and by heating the object at the opposite side; itself being converted into fuel, and excited by the blast, it creates an atmosphere of flame and heated air which surrounds the object, and prevents its heat being carried off so fast, or any great reduction of the temperature, if it should for an instant be moved out of the cone of the flame, from the unsteadiness of the hand, or from accidental currents of air, which would disturb the flame, and cause a wavering in the point of the cone.

In order to prevent more tallow from being consumed, than is necessary to produce the intended effect, it is convenient to have several lamps with wicks of different thicknesses, viz. one to hold two flat cottons, (such as are used for the Liverpool lamps,) of about 1¼ inch broad; another to hold four, and a third to hold six, or as much common wick yarn as is equal to those wicks in bulk; glass jets should also be provided of different-sized apertures, to suit the greater or lesser sized wicks or flames, and deliver streams of air upon them proportionately, and their jets should point upwards in a small degree: hog's lard is also equal, or perhaps superior, to tallow for the lamp.

For curious experiments, in which the use of oxygen gas may be desired to urge the flame, this lamp may be applied with the greatest facility, by tying a tube from a bladder con-

taining the gas to the tube C. The bladder may either be placed between the knees to be pressed when the chamber F requires air, or it may be placed upon the floor, and trod upon with the foot for the same purpose.

Description of an improved Sounding Machine.

To this invention, the Committee of Mathematics, Mechanics, and Mechanical Inventions, of the Royal Institution, wish to give every possible degreo of publicity, as it is one which must necessarily contribute to the preservation of the lives of a numerous class of our fellow subjects, while it strengthens their just hopes of security. It is a machine for taking correct soundings at sea: but previous to the description of the machine, it will be proper to examine the question of soundings in general.

Soundings are necessary whenever the land is approached, and indeed the navigation of the British channel, of the North Seas, of the Gulph of St. Lawrence, and of the greater part of the coast of America, is chiefly carried on by means of soundings: in many cases they are of more consequence than either light-houses or beacons; even one head-land has been frequently mistaken for another, and the land fall, or gradual shallowing, can only be ascertained by correct and frequent soundings. Hence it is that men are perpetually relieving each other at the lead, as there is scarcely any other means of self-preservation, during fogs and hazy weather in close seas.

Soundings have been hitherto taken by means of a lead, to which is attached a line with marks on it denoting fathoms, which being heaved over-board, the length of line is supposed to give the depth of water. The fact would be correct were the ship stationary, and it has in consequence been found *necessary to bring the ship to*, to take soundings above 12 fathoms, which appears to be about the limit at which they can be obtained, if the ship be going at the rate of five knots. When the ship is proceeding with a greater velocity, or deeper soundings are required, it will be necessary to bring the ship to, which must

be attended with much danger if in a gale, or in a convoy during foggy weather—and with much loss of time to the trader who is running to procure a good market. These considerations have been the cause of a neglect, that has cost this country numbers of lives. But in a military point of view, where is the captain who will stop his ship in chase to sound? though on an unknown coast.

To many persons, who hear so much talk of longitude and improvements in navigation, it will be natural to suppose that the exact position of a ship is easily and generally known; but such persons are probably strangers to an act of parliament of the 14th of his late majesty's reign, which holds out

To the first person who shall find the means of discovering longitude within	60 miles, a reward of	£5,000
For discovering the longitude within	40 ,, ,,	7,000
For discovering it within	30 ,, ,,	10,000

Nor is it an uncommon thing to have an error of from one to two hundred miles in a passage from America to the West Indies.

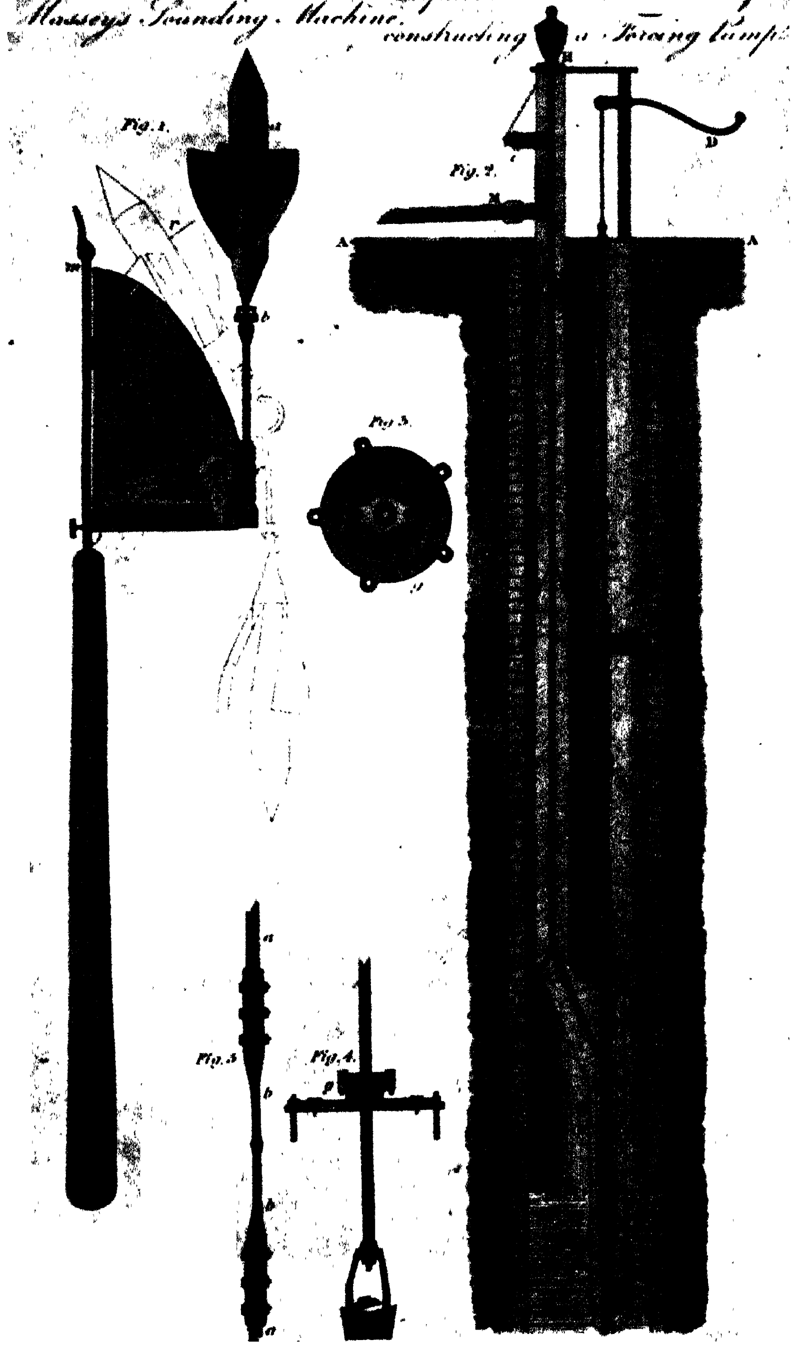
These considerations show how necessary it is to be able to take correct soundings at all times, and in all weathers, under full sail or brought to;—to be able to employ any seamen, and not particular men, who have required a long training to the business, to be able to repeat soundings often, without impeding the progress of the ship; for it frequently happens, and in the East Indies particularly, that a ship is carried away by currents from 40 to 100 miles, while the captain has perhaps no other means of ascertaining or correcting the position of the ship but by soundings.

Having said thus much on the general question of soundings, it will be necessary to describe the new sounding machine, to point out the severe trials it has been put to, and finally to show how far the invention has fulfilled the object for which it was invented.

The Inventor is the same person whose ingenuity is manifested by several improvements in clock-work, which are given in this work.

The machine consists of a rotator *a*, fig. 1, plate XLIII, formed of an air-tight tube, with four vanes solidly fixed to

Massey's Sounding Machine. Stephens's economical mode of constructing a Forcing Pump.



the tube, but inclined to the axis of it, which inclination causes the rotator to turn as it passes through the water, once in the space of five feet. Any number of rotators may be regulated to the 30th part of an inch. The rotator is attached to an endless screw *c*, (by means of an universal joint *b*, and a piece of line about three inches long,) which acts in a wheel *g* of 24 teeth, the graduated scale on the wheel being of 20 parts to convert the rotations into fathoms. An index fixed to the brass plate points to the numbers on the wheel as it turns round. The axis of the wheel is a pinion of seven leaves, that turns another wheel on the reverse of the plate of 56 teeth answering to 160 fathoms. At *k* is a notch to hold the rotator in a horizontal position *r* by one of the vanes, until the machine strikes the water, which immediately forces the rotator into the perpendicular position *a*. The brass plate is fixed to an iron bar *m j*, about two feet long, by means of the screw *l*, and by means of a prolongation of the brass plate at *j*, to which a nut is screwed on the opposite side of the bar. This prolongation acts as an axis or centre in the iron bar, to enable the brass plate to move between two small cheeks at *l*, the screw at *l* going through the two cheeks and plate at right angles with the surface of the plate, thus allowing the plate to move between the cheeks for the space of about an inch, to obviate the eddy of the plate. The line is fixed at *m*, and the lead is cast upon the bar about an inch below *j*. The brass plate projects about six inches, lest the rotator should be affected by the eddy of the lead.

When the machine reaches the ground, or is attempted to be drawn up again, the rotator falls into the position below *c*, which prevents the rotary motion; but as an additional security, a locking plate *d* is acted upon by a bolt which is fixed to and put in motion by the flirt piece *t*. During the descent, the flirt piece is kept in an upright position by the water, but ceases to be so when the machine becomes stationary, or is hauled up.

Thus it appears that the whole of the apparatus, which really indicates the soundings, is comprised in the space of about one foot, that is to say, *from the summit of the rotator to the locking plate*, without any dependence on the length of the line or rate of sailing.

Such is the description of the machine. No sooner was it completed, than it was judged to be of sufficient correctness to stand the test of the severest trials. Testimonies are frequently obtained on very light grounds; but those obtained

for this machine are of a very different stamp. Captain Malcolm, of the Royal Navy, having used this invention,* during his passage to and from the West Indies, recommended it to the attention of Admiral Montagu, who commanded at Portsmouth. The Admiral ordered "the masters of his Majesty's ships the Royal William and Resistance to proceed off the Isle of Wight for the purpose of trying the correctness of the machine;" and the joint report of the masters, in date 20th of June, 1806, was, that "sailing at the rate of 5½ or 6 knots, they got true soundings in 17½ fathoms of water, when by the hand-lead they could scarce get ground: the vessel was hove to immediately, and they sounded by a correct hand-lead and the machine, which agreed exactly. This operation was used several times, and not the smallest error found." Three days after, Capt. Hope, of the Espoir, reported to Admiral Montagu as follows: "Yesterday having a fresh breeze, going at the rate of 8 knots, I obtained soundings frequently from 30 to 33 fathoms, with 55 fathoms of line out, exactly corresponding with the soundings laid down in the general charts." It is to be observed, that Capt. Hope adds in his letter to the Inventor, "at the same time the experiment was made with the deep-sea lead, and found impracticable, in consequence of the velocity with which the sloop was going through the water."

These official certificates were so strong, that the Navy Board judged it expedient to recommend that further experiments should be made on board the Channel fleet, then under the command of earl St. Vincent. His lordship, when transmitting the reports he had received to the Board, says, "I had intended to have made further trial of the sounding machine under the Inventor's immediate inspection, in other of the detached squadrons from the fleet under my command; but the reports from Sir Charles Cotton are so satisfactory and decided, that unless you wish for further information, I do not propose any longer to detain that ingenious man from his family." On the 8th of January, 1807, Sir Charles Cotton writes: "I have the honour to inclose for your lordships'

* Captain Malcolm, in a letter of the 12th of May, 1806, says, "I used the Log Machine during my passage to and from the West Indies, and found it gave the ship's run perfectly correct." The Captain had purchased it of Capt. Whittle of the merchant service, who had carried the log out from Liverpool to Newfoundland; from thence made Cape St. Vincent, with an error only of two miles, and then proceeded to Naples, where he sold it to Capt. Malcolm.

information the several reports on Mr. Edward Massey's Patent Sounding Machine, made to me by Captains Bedford (of the Prince of Wales,) Lukin, (of the Mars,) and Neve, (of the San Joseph ;) from all of which it appears to be an invention of great utility in navigation." The following extracts from the reports of the above-mentioned captains must at once stamp the value of the discovery.

Capt. Bedford reports to Sir Charles, as follows:

"In compliance with your directions, I have caused repeated trials of Mr. Edward Massey's Sounding Machine, and, as far as I have seen, the construction and principle appear simple: and I think it a discovery of the greatest importance to navigation. The depth of water is easily and correctly ascertained (even if the ship be going six or seven knots, in sixty fathoms water) by affixing a second lead, and preventing the line from being checked; and should you not succeed in gaining bottom, you always ascertain the perpendicular descent of the lead, which in many cases (particularly approaching soundings in the English Channel) would be the greatest consolation of a dark night, when both the delay and danger attending it is often an objection to its being attempted in the present way. I am also of opinion, that in chase, or on a lee-shore, it might be of the greatest use, as no skill is necessary on the part of the person who takes the soundings, nor are the depth of water, the roughness of it, or the ship's going through it, interruptions to Mr. Massey's method of sounding."

Capt. Lukin writes:

"Agreeably to your orders, I have made repeated trials of Mr. Massey's sounding Machine, and am enabled to say, that it gave the depth of water accurately, as far as our experiments went, up to the rate of six knots.

"We repeatedly got soundings in sixty fathoms, going at the rate of five knots and a half, without in the least deadening the ship's way, with the same accuracy that could have been done with a lead and line in that depth had the ship been brought to."

Capt. Neve, after calling it a most capital invention, proceeds to say:

"The invention is the more valuable, as the process is the most simple, the whole being understood by seeing it once in use.

"I therefore consider it a valuable improvement in navigation; as in frequent and various cases, soundings could not

be gained without it. The advantages are many, such as in chase, or being chased; on a lee-shore, or doubtful of it; and to save time in running for the desired port."

These testimonies induced the Navy Board, in February 1807, to order 500 machines for the use of the Royal Navy, and about eighteen months after, gave a further order for 250 more.* Thus was the machine introduced into the Royal Navy.

Every thing now appeared to be settled, nor was any objection to the new sounding machine ever hinted at, when Captains Hotham and Bedford discovered, that if soundings beyond 80 fathoms were attempted, the air-tubes of the rotators were frequently flattened, and that few of the rotators could withstand the pressure of 112 fathoms.

No sooner was this unexpected failure made known to the Inventor, than it was instantly remedied by a small hole made in the bottom of the air-tube, which restored the equilibrium between the interior and the exterior. But thus perforated, the rotary motion was true only in as much as the descent was not less than 17 fathoms per minute. To obviate this objection, the hole was suppressed, and brass disks were introduced into the interior of the tube as a support, and they have rendered it proof against any pressure to which the machine has hitherto been exposed, as will be seen by the extracts from the following letters.

1. From Thomas Stokes, master of the fleet off Cadiz, May 31, 1810. He says, "I have had the opportunity of trying one of the rotators in a calm, and sunk it 180 fathoms, and it came up as perfect as when it was put in the water. I therefore congratulate you on having got over the only objection that seems at present to be against the sounding machine."

2. From Alexander Lumsdale, master of the Caledonia, 122 guns, September 7, 1810, who writes, "The late improvement you have made in the rotator, has made it a very complete thing. I have tried it in nearly 200 fathoms without its receiving the least injury, and am of opinion the great utility of the sounding machine only requires to be generally known, to make it more sought after."

* On the 23d of May, 1811, the Navy Board gave a further order for 1000 machines, making a total of 1750, for the use of the Royal Navy.

3. From John Tapper, master of the Clyde, July 22, 1810, who says: "I have to acquaint you that I have made frequent trials of your improved rotator in 200 fathoms, with a lead of 14 pounds attached to the proper lead* issued from the dock-yard in the manner Mr. Stokes requested, and found it equal to the pressure of the water with the above-mentioned depth and weight. It came up in perfect good state, not a drop of water had penetrated through it. My opinion is that no alteration is necessary."

He then proceeds on a subject that has not been mentioned in this report, that is to say, *surveying*, and he continues thus: "The machine is altogether an excellent invention, and I found it of very great use to me in sounding the river Tagus, where the water is deep, from 20 to 30 fathoms. In a boat with sails set, I could get true soundings in sailing to and fro; *but with the common lead, I should have been obliged to lower the sails, so as for the boat's way to be entirely lost, to get true soundings*, which enabled me to sound the river in less than half the time, *and with more accuracy*." But as this letter only relates to the survey of a river, it will be proper to add the following extract from a letter of Nathaniel Denham, master of the Daphne, October 10, 1809. "Having been on a survey between the islands of Jersey and the rocks to the southward called the Minquies, as also ranging round the island of Jersey, and along the French coast, &c. by order of Rear-admiral D'Auvergne, &c. I used your valuable machine for soundings while running on rhumb lines from one headland to another on the opposite shore, such as from La Corberre Jersey, to the island of Brahat; from La Rocheport to Chosey's; from thence to cape Frehel, &c. &c. by which means I was able to make a direct course, and *get perpendicular soundings without heaving to*, so essential to surveys, but saving also much time and trouble," &c.

Thus has the progress of the sounding machine been followed through all its stages:—a machine calculated to preserve the lives and properties of thousands. Who will not wish that the Author may derive emolument from an invention calculated to avert the arm of desolation in present and future ages!

* It has been found more advantageous to fix the additional lead at 30 or 40 fathoms *above the machine*, by which means the buoyancy of the line is compensated, with less danger of the line breaking when the machine is hauled in.

An improved Shop-board for Tailors.

This improved shop-board is intended to obviate the diseases to which tailors are subject, from their constantly sitting in one injurious position. By its use, the tailor may work at his business, either standing or sitting, with equal ease and despatch. The Author was prompted to the invention by his own sufferings from bad health, which was brought on by following the practical duties of his business; he has obtained complete relief by its adoption. There cannot be a doubt, that thousands have fallen a sacrifice to the disorders brought on by the position universally required in the common mode of working at this trade; and therefore, instead of raising the voice of prejudice, to oppose the progress of an invention, which promises, by the easiest means, to remove such an enormous evil, the examination of its merit ought to be strongly encouraged; and it must be observed, that by the evidence of practice, as well as of opinion, many experienced workmen declare its advantages to be considerable, not only as to their health, but in point of ease.

AA, fig. 2, plate XLII, represents a table, fifteen feet long, and seven feet wide, with several apertures in it, for as many different workmen; and before each is a cushion mounted on a stem, which is adjustable, in height and distance, so as to be rendered the most convenient for the work, which is pinned or laid upon it. At each end of the table, four square holes are situated together, as marked at *a a a a*, and *b b b b*; and in the centre, between them, is a hole for the reception of the stem of a candlestick *d*, (see also fig. 5,) which therefore serves all the four workmen. The cushions *e e* are stuffed, covered with cloth, and mounted on upright stems *f*, fig. 3; the stems pass through grooves in the table, and each is fitted through a piece of board *g*, fig. 3, which is situated beneath the table, and slides in a groove, formed by two pieces of wood *h h*, nailed fast thereto, and being rabbeted, to keep the board in its place; the stem *f* is at liberty to slide up and down, through the board *g*, and this admitting a horizontal motion, the cushion can be set at any height above the table, or at any distance from the workman, within the limits of the stem, and of the groove in the table.

In some parts of the board, three workmen are placed together, as at *k k*, one cushion being placed between them;

if they are all wanted to work at one garment, it is then made triangular, as shown by fig. 4. In other parts of the bench are single standing places, as at *l*; these are to be placed before the window, for day-light work; the four at *a a a a*, being situated so close to each other for the sake of the common light from the candle.

The three holes at the back edge of the board are so placed as to gain light between the front men.

The stem of the candlestick, fig. 5, is cut into a screw, upon which a round block *r* is fitted, and this carries the sockets for two or three candles, which can, by turning the block round, be set at any required height. The workman may stand upright upon the floor, or, when tired of that position, may sit upon the edge of the table, and place his feet upon a stool *m*.

There are also four legs *n n*, surrounding the four holes *a a a a*, and in these mortises are made, for the reception of tenons upon pieces of wood which project a few inches; these are for the supports of his feet, when seated upon the table, so as to elevate his knees sufficiently to use the board, and hot iron, for pressing down seams. They may be mortised at different heights, for the convenience of suiting men of different stature.

The holes in the table have covers fitted into them, when they are not in use, by which the table is rendered fit for cutting out work, &c.

By placing their work upon these cushions, the men work more conveniently than by the awkward and unhealthy practice of sitting cross-legged upon a shop-board, for the mere purpose of having their knees to support the work. In marking, the tailor must have a clear board to lay his garment before him; he must unscrew the cushion, and draw it clear out, laying it aside till he has done fitting and marking, when he must resume it again.

The cost of this apparatus is trifling; a table fifteen feet long by seven broad, will accommodate seven workmen. The standing position will be found extremely easy. Suppose the man to be standing upright in the hole, raising his cushion to the waistband of his small clothes, screwing it steady with his right hand, advancing his breast, (for the old plan of stooping must be entirely rejected,) and only directing his head and eyes to the cushion, he stands perfectly free and conveniently. When tired of standing on one or both feet, and of resting his legs by turns on the stool, he may, by a brisk spring, draw the

cushion towards him with his right hand, and move the stool with his feet at the same time. These motions are instantly executed, and the man by habit is rendered scarcely conscious when he performs them.

Method of fixing Pivots, or Gudgeons, into the wooden Axis of a Water-wheel, which will prevent the Danger of their getting loose in the Shafts, and permit their being repaired when damaged.

The ordinary method of fixing gudgeons into wooden shafts, is to have an iron cross formed on the end of the gudgeon, which is let into the wood, to a considerable depth, and is held fast by small wedges, driven in round it, hoops being fitted round the outside of the shaft, to prevent the wedges from splitting it. The defects of this method are, that the shaft is much weakened, by the cutting into it; and the constant strain of a heavy wheel, always acting in different directions, causes the wedges to become loose, and at length fall out; but the failure of the gudgeon is frequently attended with more serious damage, for the wheel falling upon the bottom of the race, generally breaks the rim and buckets by its own weight.

The improvement proposed, consists in applying a cast-iron box or socket to the end of the shaft, and to this the iron cross of the gudgeon is screwed, so as to fasten it more firmly than by the old method, and without weakening the wood by cutting it away.

AA, fig. 1 and 2. plate XLIV, represents a portion of the end of the wooden shaft, which is of an octagonal form, and has the water-wheel fixed upon it; it is long enough to reach across the pit in which the wheel works, and having a gudgeon at each end, is supported and revolves upon them in proper bearings.

BB is the cast-iron box, fitted fast upon the end of the shaft, and being wedged tight, preserves the wood from splitting as effectually as any hoops can do; upon the end of

the box is a projecting flanch, *a a*, and in the face of this four grooves or notches are made, for the reception of the arms of the iron cross *b b*, *d d*, which is part of the gudgeon C, on which the shaft revolves; this cross is firmly attached to the box by four screw-bolts, which pass through the flanch, and also through the ends of the arms of the cross, having nuts screwed on the outside, to make all fast.

The section, fig. 3, shows the cross *b b*, and box BB, separated, to explain the manner of fitting them together, the inside face of the cross having projections *e e*, which enter the end of the box, and keep the pivot in its true centre; thus the bolts have only to hold the gudgeons fast on the end of the box, the principal strain being taken off by this manner of fitting the cross into the box.

When the gudgeon of a wheel, fitted on this plan, becomes worn, so that a new one is required, it can be removed by taking off the four nuts, and a new one applied.

The cross and gudgeon being of small dimensions, its cylindrical part, O, may be very conveniently turned in the lathe.

The adoption of this improvement will be attended with a considerable saving in the first cost. In the old method the hoops alone cost about four guineas, and the cast iron gudgeon £2 12s; whereas the whole expense of the new plan will only be £4 16s for the same wheel.

Method of curing British White Herrings, in Imitation of the Dutch.

As soon as possible after the herrings are caught, they are gypped, by cutting the blood-veins of the neck across with a small knife made for that purpose; the small guts are to be drawn out at this incision by the knife, and at the same time the neck-piece is to be cut out, right under the two fore fins. The herrings must then be thrown into a tub, and well roused, (mixed up with salt,) and packed immediately whilst bleeding into the casks, laying a sufficient quantity of salt between each

layer of herrings. Foreign salt has been usually employed, but *British solid salt is equal, if not superior* to foreign for this purpose. Agreeably to the Dutch system, the herrings must be laid on their backs in the cask; the casks must then be headed up and laid on there sides for a fortnight or three weeks, then opened and filled up, after which they may be put by for shipping.

The Society for the Encouragement of Arts, &c. on receiving the above directions for curing herrings, with a sample, consisting of a half-barrel, produced by the process, procured the attendance of several very respectable Dutch merchants, and other persons from Holland, well conversant in the business of taking and curing herrings, to afford further information on the subject, and to examine the half-barrel which had been received. These gentlemen, having finished their examination, and eaten heartily of the herrings, concurred in the following sentiments :—

That the sample of herrings examined by them had been cured precisely according to the Dutch method.

That the Dutch in their cure use generally the best Lisbon salt, well crystallized, in the proportion of one thousand pounds weight of salt to fourteen barrels of herrings, each barrel containing from 1000 to 1200 herrings, according to their size.

That the Dutch commence their herring fishery on the 21st of June, and continue it from 58 to 60 degrees north latitude to the latter end of August, following the herrings, and continuing their fishery of them southward, from that time to the latter end of October.

That the Dutch always pack their herrings in oak casks, and for the West India trade pack them in small casks, as a cask of herrings will not keep long there after being opened.

That the signs of a good herring are, that the fat should run from the hands in opening it, the flesh appearing clear and white, and the flavour not too salt.

That the herrings caught in October, in latitude 40 degrees, are the best calculated for the West India markets; having then shot their roes and become meagre, they will therefore keep better.

That the Dutch herrings will keep good 12 months.

That the herrings submitted to their inspection by the Society, were extremely good, and equal to the best Dutch, only rather too salt for home consumption. They recommended that for the West India trade they should be repacked in

smaller barrels, in the following manner:—The herrings should be laid upon their backs very close to each other, the heads turned towards the outer circle of the cask; that when a layer is thus placed and pressed hard, some salt should be taken up between both hands open, and by a sudden jerk dispersed equally over the layer; the next layer of herrings should be laid directly cross-ways of the former, pressed and sprinkled with salt as before, and the herrings thus closely placed, salted and packed, stratum super stratum, till the cask is well filled.

They stated that the herrings are usually eaten in Holland as taken from the cask, without boiling or other culinary preparation, but that the roes are usually broiled.

To prepare for eating, the herrings before them, they took them from the cask without washing, and cut off a small slip, the whole length of the belly, as useless; an incision was then made the whole length on the back of the fish, and the entire skin of the herring dexterously drawn off, commencing at the throat of the fish. The fish was then cut across obliquely in the direction of the vertebre, in pieces of three-fourths of an inch each, containing the bone in the centre of each, and thus laid on a plate for the table, to eat with bread and butter. Some of them were prepared in another mode, by holding the fish when skinned as before, by the finger and thumb of each hand; and by dexterously turning it over the wrists, the herring was split the whole length, and separated from the bone leaving the whole fleshy part in two longitudinal pieces.

A new British Method of curing Herrings.

Take 4500 herrings (which will fill 3 barrels of 32 gallons each) procured from the fishermen the day they are caught, and before the setting of the sun if possible. With spring sheep-shears cut off their heads, and disembowel them by cutting the belly longitudinally about one-eighth of an inch beyond the belly fins, and put the heads, bowels, and roes into a copper, with six gallons of water and six pounds of salt, from the quantity allowed by government, (which is

140 pounds of salt per barrel;) boil this mixture slowly for four hours till it becomes a pulp, then strain it through a clean hair sieve, and when you have drained the liquor, cast the dregs into a press, within a horse-hair bag, and compress the dregs forcibly to discharge all the contained liquid. When this liquid has stood till perfectly cold, an oil will arise on the surface, which must be carefully removed; then press the liquor through a clean hair sieve, and preserve it safe.

After taking off the heads and disembowelling the herrings, as above-mentioned, take the bodies and put them into sea-water, in a large tub provided for the purpose, 500 herrings at a time, and stir them well about therein with a broom to cleanse them from all filth; next cast them into wicker baskets to drain for about fifteen minutes; then take for the three barrels 1½ pound of black pepper ground, 1½ pound of ginger, three quarters of a pound of sassafras powdered, and six pounds of coarse-grained raw sugar, and the remainder of the salt allowed by government. Mix these ingredients well together, and put the mixture and the 4500 herrings into a reservoir, and stir them well together with a stirring staff similar to that the brewers use in mashing; let them remain thus for three days, then take three thirty-two gallon oak barrels, and place 1500 fish in each barrel, coopering them up as soon as the fish have shrunk so as to be compressed therein; when coopered, place the barrels on their sides, gun fashion, pouring first into each barrel one gallon of vinegar, No. 24, and then add a proportion of the liquor prepared as before-mentioned, from the heads and bowels, also that from the salt and spices, all well mixed together: and let the casks be well filled up therewith, and bunged, placing them so as to be rolled about, in order that every part of the barrel be well filled, as the surest means to prevent rancidity. When you have carefully ascertained, after rolling for several successive days, that your casks are perfectly full, bung them down securely, and let them stand some months, when they will be fit for market. The herrings thus cured will remain good for several years.

If a larger quantity of fish is caught than can be discharged of heads and bowels before the sun sets, put those fish which you cannot operate upon (after first washing them in sea-water or salt water) into a reservoir with the quantity of salt allowed by government, stirring the salt and herrings together; then take the first opportunity to separate the heads and bowels, wash them in some of the salt liquor, boil the heads and bowels as before, and strain this liquor through a

clean hair sieve; place the pepper, ginger, sassafras, and sugar, in the reservoirs with the washed herrings for three days, then proceed to barrel them, adding first one gallon of vinegar; then fill up the cask with the boiled liquor, and the pickle prepared from the spices; proceeding as above-mentioned.

Sprats may be cured by the above process, with the addition of two pounds of saltpetre pulverized, for each cask of 32 gallons; it is immaterial whether they are cured with or without the heads and bowels.

This process for curing herrings, will be found rather more expensive than the Dutch method, detailed in the preceding article; but it gives the herrings a peculiar mellowness and fine flavour, much resembling the anchovy, and they may be employed in many cases as a valuable substitute for anchovies.

Method of curing Mackarel.

The salt used for the pickle, is British solid salt, refined by fusion, in which operation the impurities are separated by precipitation.

The strength or specific gravity of the brine in which the fish is cured, is to the specific gravity of water, as 1205 to 1000.

The fishing boats should take out with them vessels containing brine of the strength above-mentioned, and the moment the mackarel are caught, they are to be put alive into this brine, without gutting, or any other preparation. On barreling them, a surplus of dry salt should be added to the cask, to strengthen the brine, which is become weaker, from a portion of its salt being absorbed by the fish, and the natural moisture of the latter.

These are all the necessary operations; the expense of the salt is trifling, as government allow a drawback of the duty on all salt used in the fisheries.

The curing of mackarel whole, had, previous to the adoption of the above plan, been deemed nearly impracticable; split mackarel had indeed been salted and preserved, but not in a state of excellence.

The flavour of these cured mackarel is thought by competent judges as extraordinary as their preservation; they have been used for sandwiches, and considered for the purposes of the table, equal, if not superior to the anchovy. A specimen of them being submitted to examination, at a meeting of the Directors of the British Herring Fishing Company, they testified, in a certificate which they freely gave to the Inventor of the process, that the mackarel thus cured, far surpassed, in goodness of taste and colour, any they had ever before seen. The natural outside appearance of the mackarel was preserved nearly as bright as when they are fresh, although they had been in pickle several months; and when cut, they were in high perfection, being of a reddish colour, very moist, and excellent in flavour.

The purified, or patent salt, used to cure the mackarel, contains, according to the experiments of the Inventor, 570 parts of marine acid, 425 parts of soda, and only 5 parts of extraneous matter, in 1000 parts of the salt. Its purity, therefore, doubtless, renders it particularly well adapted to the curing of fish. A greater proportion to the salt in lumps should be added to the pickle, than can be dissolved, because there always should remain a portion of undissolved salt, ready to counteract by solution, any tendency to putridity that may arise in the fish.

The fishery of mackarel may be carried to an immense extent on the British coast; which renders the present discovery of an unexceptionable mode of preserving this fish, an object of great national consequence, both with a view to home-consumption and foreign trade.

A Guard for a Carriage-wheel, by which the Wheel is retained safe upon the Axle, in case of the Linch-pin coming out.

This contrivance may be applied to any carriage, as it does not require any part of the carriage or axle-tree to be altered farther than the addition of an extra iron hoop upon the inner end of the nave of the wheel. This is fully explained by figs. 4 and 5, plate XLIV, the former being a section,

lengthways of the axle-tree; and the latter a transverse section.

AA, represents the iron axle-tree of a carriage, bolted beneath the wooden bed BB, or frame of the carriage.

CC is the wheel, DD its nave, the axle-tree box *d d*, being fitted through the centre of it as usual: *a* is the linch-pin, passing through a mortise in the end of the axle-tree.

EE is a circular box, fastened to the bed BB, of the carriage, and surrounding the inner end of the nave of the wheel, to prevent dirt from getting into the axle-tree; the extra hoop before mentioned, which is fixed on the end of the nave, is contained within this box, and runs round without touching it; it consists of a strong hoop *b b*, fixed fast upon the nave, and having a flat circular ring formed out of the same piece with it: the latter, when fixed, makes a circular projecting rim, upon the end of the nave, as the figure plainly shows.

The same clasp band F, which, by means of two nuts beneath, fastens the axle-tree AA to the bed of the carriage, also fastens down a piece of iron, G, upon the bed B. In the extremity of this piece of iron is a hole for the reception of a screw *e*, the point of which enters within the box EE, and comes before the projecting ring *b b*, so as effectually to prevent the wheel from coming off its axle, even if the linch-pin should by accident drop out; the point of the pin *e* is so situated, as not to come in contact with the plate *b b*, when the linch-pin is in its place, therefore it occasions no friction to retard the motion of the carriage.

When it is required to take off the wheel, for the purpose of repairs, or for greasing the axle-tree, the screw *e* is taken out, and the linch-pin being removed, the wheel can be taken off.

This invention, soon after it became known, was generally adopted by the Proprietors of the coaches on the Bath and some other roads, and proved the occasion of preventing many accidents.

In the next article we shall describe an invention to be applied to the linch-pin of a carriage, to prevent the wheel coming off its axle, if the linch-pin should drop out. This contrivance being wholly applied at the extremity of the axle-tree, close to the linch-pin, it may be used in combination with the carriage-wheel guard above described, and the inventions thus used conjointly, would render a carriage so secure, that it would be scarcely possible for the wheel to come off by

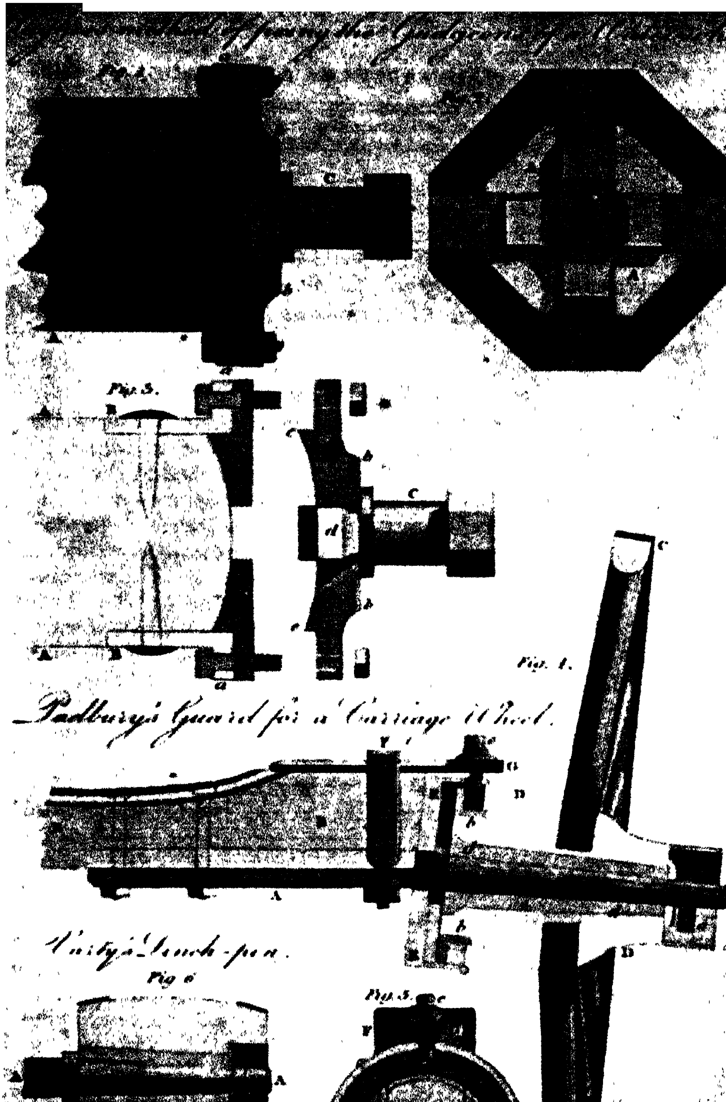
any accident short of the breaking of the axle-tree; and even then there would be a chance of the wheel being retained, in the circular box EE, by the point of the screw *e*, so as to sustain the carriage from falling until the horses could be stopped.

Method of preventing the Accidents occasioned by the Linch-pin of Carriages coming out.

The contrivance for this purpose is shown in figs. 6 and 7, plate XLIV.

Fig. 6, is a section of the nave of a carriage-wheel, with the axle-tree AA in it; and fig. 5 is a separate view of the axle-tree. *a*, fig. 7, is the linch-pin detached; it is put through an oblong hole in the axle as usual, but there is likewise an additional linch-pin *b*, to make it complete; which is fixed in a recess cut for it in the axle, and turns on a pin (as shown in the figure) into the hole left by removing the linch-pin *a*, when the wheel is to be taken off; but if the linch-pin *a* should accidentally get out, this additional pin *b* would effectually keep the wheel on, as its hanging position does not at all tend to shut the pin up into the axle, but the contrary. The common linch-pin *a* is put in downwards, that its weight may also tend to keep it in, and it is secured in the usual way by a strap, the holes for which may be seen in the figure. The whole, when in its place, is shown by fig. 6.

The first trial of this linch-pin was made on the stage-coach, which ran from Liverpool to Lichfield, a distance of eighty four miles, six days per week. During the space of six successive months, although in several instances the linch-pin came out, not a single accident occurred.



Published by Henry Fisher, Caxton, London 1823.

Description of a temporary Rudder, which can be quickly fitted out by a Ship's Company, when at Sea, and from such Materials as are always kept on board.

This invention consists of a top-mast, placed out of the ship's stern, having planks fixed at the end of it, which go edgeways through the water. The mast is attached to the stern by a kind of joint or socket, on which, by proper guys, it can be inclined in an angle, with the keel either larboard or starboard; and will steer the ship as effectually as a proper rudder.

Fig. 1, plate XLV, shows an elevation of this machine in action; fig. 2, a plan answering thereto; and fig. 3, all the parts detached, and ready for launching over the ship's stern.

To fit out a ship on this plan, the following materials must be collected and prepared as soon as the rudder is gone, or expected to be lost.

1st. A spare top-mast, AB, fig. 2, and two blocks *h h*, which must be securely lashed on at each end of it.

2nd. A top sail-yard CD, which must have cleats, nailed securely upon it, forming a shoulder at the end C, which is to be kept on board; and at the opposite end must be framed a case *e e e*, formed of pieces of oak plank, nailed firm to the yard, on each side, the left or foremost part being chamfered off, and leaded; so that, by presenting a narrow edge, it may make the less resistance in passing through the water.

As the taff-rail will not, in general, be found sufficiently strong to resist the force of the machine; a frame *k l m n*, must be composed of substantial pieces of oak, and erected behind it, upon the deck; it consists of two uprights *m m*, set up from a sill *n*, which is spiked down upon the deck; and they support a rail *p*, which is firmly lashed to the taff-rail; and the whole is strengthened by three shores *k k*, stepped from the deck to the uprights *m m*; between these is supported a piece of oak *l*, four inches and a half thick, with a hole through it, of a proper size to receive the end *f*, of the yard; the hole is leathered inside, in which the end *f*, of the yard, acts with perfect ease, and can swivel about in all directions; the tapered end *f* of the yard is leathered also, that the whole may act easily.

While these parts are preparing by one part of the crew, some should get the top-mast A athwart-ship, over her quarter, and make it fast by proper lashings; the others should be ready with the several tackles which rig it out, to give motion to the rudder when in the water. They are as follows: two principal guys, *a a*, made of rope, which is 5½ inches girt, and should be of very good materials: they are to be made fast to the boards at *e e*, and carried through the top-blocks at *h h*; the end has the block *r*, of a luff-tackle purchase, turned in; the other block being lashed to one of the stancheons on the ship's quarter, and the fall carried through the leading blocks *s s* to the steering wheel F, situated upon the ship's deck.

A topping-lift, *b b*, suspends the weight of the rudder from the spanker-boom G; it is a gun-tackle purchase, and is of great use in getting the machine out of the water, and also to assist in getting it in; the fall of the purchase is carried along the boom to a cleat spiked to it.

c Is another topping-lift from the rudder to the mizen-mast head; it likewise assists to get in the machine, as well as for a substitute, should either of the guys break;—it should be 3½-inch rope.

Two short luff-tackles *d d*, fixed to the taff-rail and cross-piece *p*: they are for the purpose of holding the end of the mast firm in the socket, and materially aid in placing and displacing it.

A jack-stay *i*. This is a rope stretched tight from the planks at *e e*, to the other end of the mast; on this a weight, *t*, is suspended. The machine is ballasted sufficiently for common occasions, when the ship is going less than 8 knots; but this additional weight, consisting of shot sewed up in canvass, is to assist in keeping the whole of the machine in the water, when going more than 8 knots; and when going less, to be hauled up by the line *v*.

The mode of operation in this machine, will appear evident from the above description; the steering wheel F, being turned either way, acts to bring in the fall of one of the guys *a*, and give out the other, producing an inclination of the rudder, as in fig. 2, so as to put the ship about as expeditiously as a common rudder, and upon the same principle, viz. that of making a resistance to the ship's motion, on either side of her keel, at pleasure. The ship Cornwall, in which the contrivance was first tried, had her wheel fitted close to the rudder head, and she steered with a short tiller abaft the rudder. In ships

fitted in the common manner, the tackles would lead to their wheels in a similar way; the only alteration from the figure being, that the wheel is placed much further forward on the deck, and the leading-blocks *s s*, are of course placed opposite to it.

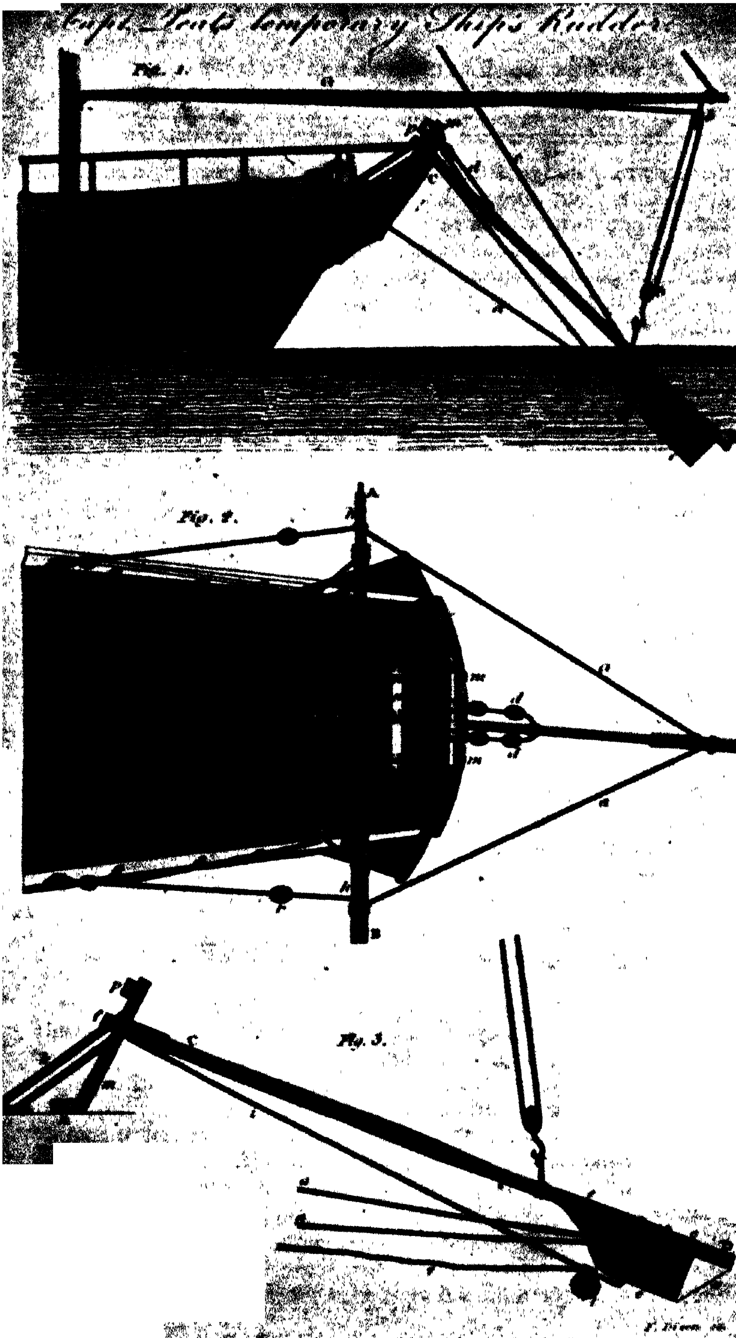
It may not be uninteresting to advert to the circumstances under which the temporary rudder above described was first thought of, and brought to its present state. On the 29th of December, 1810, the transport ship Cornwall, Captain Peat, set sail with a fair breeze, from Portsmouth, bound for Barbadoes. Till the 3rd of January, the weather continued favourable, but on that day, with a change of wind, a violent storm commenced, and by repeated shocks of a heavy sea, their rudder was carried away. The signals of distress which they hoisted to the only vessel which hove in sight, were not perceived; the ship laboured very much in the trough of the sea, and made a great deal of water; the hatches were battened down, the dead-lights in all the windows; and the storm increasing rather than lessening, on the following day, (the 4th of January,) no provisions could be served out to the troops, of which there were 225 on board. In this state of extreme peril and dismay, it became absolutely necessary to devise some method of governing the vessel. The Captain having searched a book on naval tactics, which he happened to have in his possession, found a plate of Pakenham's temporary rudder, which gave him some little hopes of success; but on further investigation, it appeared impracticable to ship a rudder on that plan, even if they could have succeeded in fitting it, owing to the heavy sea that was running; besides which, they had no spare cap on board, and as they steered on the upper deck, the sea must have been perfectly smooth to succeed in getting the rudder-head up the case, without materially injuring the counter. At this period, one of the seamen stated, that he had been on board a Turkish frigate in a similar situation in the Mediterranean sea, and they managed to steer the ship tolerably well under her head-sails, by means of a machine placed over the quarter or stern of the vessel, (he could not recollect which,) but it was made from a spare spar, with a gun-carriage fixed to the end of it. Pursuing this hint with all the diligence which the urgency of the case required, and adding every improvement which his experience suggested, the Captain proceeded to give directions for forming a temporary rudder. On the 6th of January, while they were employed in this undertaking, and were yet uncer-

tain of their final success, a ship came within hail to leeward. They made repeated signals of distress, accompanied with guns; the sea was too rough for a boat to be sent on board, but they implored the commander to stay by them, and to tow their head round to the westward; he was aware of their loss, yet did he make sail from them without learning whether they were in a leaky condition, or in want of a supply, or where they were destined to. They afterwards found that this ship was the Sally, of Liverpool, commanded by George Knebly, bound to St. Kitt's. Their only hope now rested on their own exertions, and, notwithstanding the interruption occasioned by the violence of the weather, on the seventh of January a rudder was completed, which, with all the head-sails set, wore ship, and went 7½ knots per hour, for the whole twenty-four hours, to the inexpressible joy of every soul on board. Subsequently, they found it advantageous, though not absolutely necessary, to make several improvements in this machine; and upon the whole, from the period of its being first begun of, till completely finished, and in the state described in reference to the plate, it was eighteen successive days in hand. When finished, it admitted of a press of sail being carried, and the vessel made nearly a direct course to Barbadoes, where it arrived on the 10th of February.

At Barbadoes, a survey was taken of the temporary rudder by seven professional men, in the king's and merchants' service, and it was unanimously admitted that the vessel might, with the utmost safety, proceed on its further destination to Jamaica, as the temporary rudder was actually a better one than the island of Barbadoes could furnish. Accordingly, having weighed anchor on the 13th of February, the Cornwall proceeded to Jamaica, and made the passage, which is 1000 miles, in rather less than seven days.

Thus ended a voyage in the ship Cornwall, having sailed four days from England when she lost her rudder, and afterwards having in the whole run a distance of at least 1250 leagues, being at sea forty-one days, with a temporary rudder contrived and executed at sea under the pressure of severe distress, during a winter's storm.

Anthony Lockwood, master attendant of the king's naval arsenal at Barbadoes, and who was one of those who concurred in the complete eligibility of the ship to take another voyage, without further repairs, himself went in her to Jamaica, to form a correct judgment of the real merit of the invention. He states as the result of his examination, that



Temporary Ship's Rudder
Fig. 2.
Fig. 3.

Capt. Peal's temporary rudder, which may be fitted up in all weathers at sea.

during the passage from Barbadoes to Jamaica, this machine acted with great effect, the ship carrying royals and all studding sails night and day, and for several hours together going 10 and 10½ knots, during which time she required less wheel than with the common rudder, and at no time did the temporary rudder require to make an angle of more than 10 degrees, either in the act of wearing or tacking. This simple and truly ingenious method of governing a vessel in distress, he therefore earnestly recommends to the notice of all persons subject to casualties, that may require an expedient of this kind; and although temporary rudders are no new subject, yet the one here delineated is unquestionably the best ever held to public view.

The circumstances favourable to the machine, are,

First, its being composed of such materials as vessels of every description are possessed of.

Secondly, the simplicity of its composition, superseding the absolute necessity of a carpenter.

Thirdly, that it may be constructed and put in action, even in a gale of wind, in two, or at most, three hours.

Its properties are,

First, that it can be shipped at pleasure, without delay, and with very little trouble.

Secondly, that it cannot by any shock or violence be rendered unfit or useless.

Thirdly, that the guy tackle fall, being brought to the wheel, requires only the same force to steer as the common rudder; that the ship is under complete command, appears from the log-book of the Cornwall, in all the following cases:

"Gale of wind, heavy sea, wind quarterly."

"Light winds, heavy swell."

"Fresh wind, spanker, main-sail and all sail, on a wind, off the wind."

"Staying and wearing."

A. Lockwood proceeds to observe, that the sole object of his evidence and exposition on this subject, being to benefit the nautical world, he cannot in justice forbear to suggest, what in his opinion would, with little additional trouble, be a great improvement. The body of dead water occasioned by the flat open part *x*, of the planks at the end of the yard, tends to impede the ship's progress, and to force the case upwards, which consequently strains the guys when going very quick. The dotted lines at *x*, fig. 3, he therefore proposes to be a piece of plank, to be contrived on the end of the top-sail yard, so formed or filled up as to carry off the body of water complained of.

A Guage for the purpose of marking a Line along the centre of any parallel or inclined Surface; also for finding the centre of a Circle, Square, or any regular Polygon.

Fig. 1, plate XLVI, is a plan, and fig. 2 a perspective view of the gauge; the same letters refer to both figures; the first of which is drawn to exactly half the dimensions of the instrument itself.

AA is a square bar of hard wood planed straight; having the two cheeks of wood BD fitted upon it; the cheek B is fixed fast upon the end of the bar, whilst the other slides freely upon it, but may be made fast, at any required place, by the thumb-screw C. At the end *b*, a common scribing point is fixed in the bar, and with this, and the sliding piece D, it forms the common guage used for describing parallel lines from the edge of any piece of woodwork; the improvement consists in adding two brass arms E and F, of equal length, which are centred in the two sliding-boards, or cheeks, at *a a*, the other ends are joined together by the screw G, which is formed into a sharp point beneath, to mark the work with.

In using this guage, its two cheeks BD, must be set to the width of the piece of wood intended to be scribed, and applied as shown in fig. 2. It must be evident, that the point of the screw G, will always keep in the centre between the two cheeks BD, because the two arms EF are of equal length, and a line joining their centres *a a*, is perpendicular to the cheeks; it may also be used in the manner of the common carpenter's guage, by means of the sliding cheek D, and the marking point projecting below the bar at *b*.

This tool will prove more conducive to expedition than the usual method practised by carpenters, for finding the centre of any piece of board, viz. by setting the common guage, as near as can be estimated; to the centre of the piece, and making a mark, then turning it to the opposite side of the piece, and making another mark, between which, if the distance be made very small, is found the centre, near enough for common purposes.

If the piece of work to be guaged, is not parallel in its width, then the screw B must be loosened, and the two cheeks kept pressed together with sufficient force to keep them in contact with the two sides of the work, when the point G will

traverse along the centre as correctly as if it was a parallel, because in all situations, it preserves an equal distance between the two cheeks. The two cheeks have grooves in them, to admit the brass arms E and F, when the cheeks are brought into contact.

The cost of this improved guage is about four shillings.

An expanding Centre-bit, for boring circular Holes of different Diameters through Boards, without wasting the Pieces which are cut out.

Figs. 3 and 4, plate XLVI, explain two different methods of constructing centre-bits: fig. 3 is the instrument designed for large holes, even as much as 9 or 10 inches in diameter; while fig. 4 is intended for holes of all diameters.

The large tool, fig. 3, consists of a straight bar of iron AA, with a shank B, projecting perpendicularly from it, and formed into a square at its top, to be received into a stock or brace, in the manner of a common centre-bit. CD are two cutters sliding upon the bar A, and may be fixed by the screws EE, at any distance from the centre-pin F, to regulate the diameter of the hole intended to be cut out. The centre-pin F is screwed into the underside of the bar, and its bare and sharp point projects some distance before the edges of the two cutters CD. The cutter C is made rather longer than D, and is formed into two sharp cutting edges, which cut two parallel lines round the circle, for the other cutter D to follow in, and take out the wood between them. By this means the wood is not split, nor jagged, but an even hole is produced.

The form of the cutting edges is shown on a larger scale in figs. 5 and 6, the latter showing the two sharp scribing edges to cut the sides of the circular groove; and the other, the sharp hooked edge, which cuts up the wood from between them, in the manner of a chisel.

Fig. 4 shows the construction recommended for smaller expanding centre-bits. The shank A is swelled out at its lower part into a square D, large enough to have a mortise or socket made through it, for the reception of two arms, which are bent down at right angles at the ends, and form the two cutters BC; these arms are in separate pieces; they lie

upon each other when in the mortise, but can be removed from the centre both ways, to the size of the intended hole, and be again bound fast in the mortise by the screw D. The cut[illegible] trepin E, and the two cutting edges of the arms BC, are like those shown on a large scale at figs. 5 and 6; the one, fig. 6, coming first into contact with the board to be perforated, makes, as in the other centre-bit, two deep lines parallel to each other, and of the same distance apart, as the width of the opposite cutter, which is shown at fig. 5.

The middle piece F, is made pointed and sharp, in order not to impede the action of the cutters when in use.

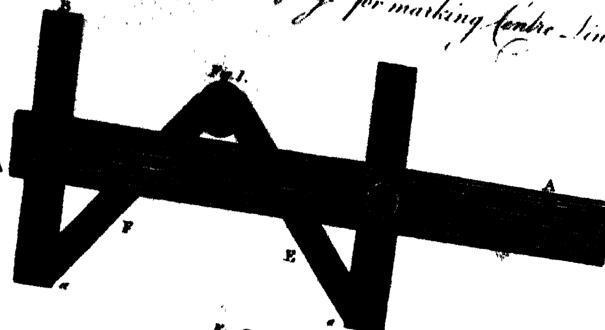
As the cutting part, fig. 5, should exactly follow the path of the marking part, fig. 6, it is obvious that it should be set at exactly the same distance from the centre or axis upon which the instrument turns. For this purpose, it would be an advantage, if the bar AA, fig. 3, were graduated, and the divisions numbered on each side from the centre. The danger of error is not so considerable in using the smaller instrument, fig. 4, but still it would tend to save time, if it also were graduated, commencing the division from the extremity of the horizontal parts of the arms BC.

Economical Method of constructing a Forcing Pump, of Wood, to raise Water from deep Wells.

The principle and general construction of the forcing pump is well known; but the cheapest mode of forming an effective machine of this kind seems not to have received much consideration; hence persons who are in want of one, either incur much unnecessary expense, or the estimate of its cost discourages them from furnishing themselves with it, although it would probably prove an important convenience. In the construction of the forcing pump, of which we shall now give a description, the attempt has been made to combine simplicity and economy to the utmost, without sacrificing power, or facility of working. The materials of which it is made are mentioned, and the greatest part of the work may be done by any ordinary carpenter.

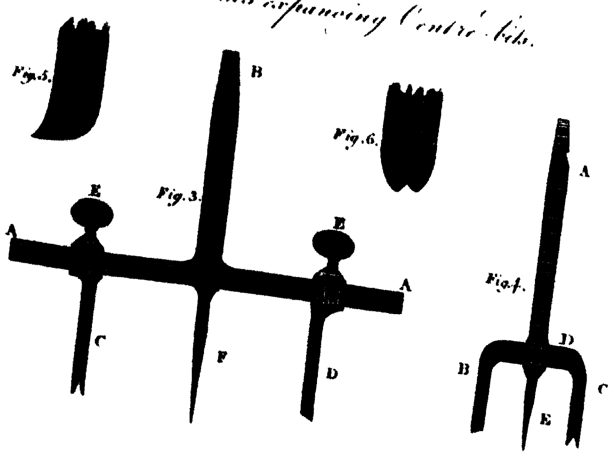
Fig. 2, Plate XLIII, is a section of a well, in which a pump of this kind is fixed.

Palmer's Gauge for marking Centre Lines.





Stones expanding Centre bits.



Stevens's forcing pump to raise water from deep wells.

AA represents the surface of the ground, and BB the brickwork of the well, in which the water stands at the level C, and is by the pump to be raised to the surface AA.

D is the lever or handle of the pump, which has the rod *a* jointed to it, and descending to the pump; the rod is made of wood, in several lengths, which are united by joints of iron, in the manner shown at fig. 5; the wooden rods *a a*, are capped with iron forks *b*, which include the ends of them, and are riveted fast; the ends of the forks are jointed together to connect the several lengths.

E is the working barrel, or chamber, of the pump, in which the bucket *d* works; this part is formed of a tree, bored through, and is lined with a brass tube where the bucket works; a projecting branch *e*, which is bored obliquely to the barrel, forms the lower part of the forcing pipe; in the bottom of the barrel the suction valve *f* is situated, being at the top of the suction part of the pump, which is bored with a smaller auger than the working chamber.

The top of the barrel is covered with a metal lid *g*, (see also figs. 3 and 4,) which has a stuffing box in the centre to receive the metal cylindrical part of the pump rod *h*; to the lower extremity of this the bucket *d* is fixed. The metal lid consists of a ring, which is screwed to the wooden barrel by five screw-bolts, passing through as many ears, projecting from the circumference of the ring; they have eyes below, to hook upon pins, which are fixed in the wood; but project sufficiently for these bolts to hold, and are formed into screws above, so as to hold the ring firmly down, by means of nuts screwed upon them. The moveable lid of the pump, which has the stuffing-box *g* formed in the centre of it, is screwed to the ring by five screws, and these can be taken out to remove the lid, and draw up the bucket when it requires to be leathered.

F is the forcing pipe, formed of as many pieces of wooden pipes as are required to make up the length; they are united by making the upper ends conical, to enter a similar cavity made in the lower end of the next pipe; the lowest piece fits upon the extremity of the projecting branch *e*, and a valve is proposed to be put in the pipe, at this joint, to prevent the return of the water, and bear part of the weight of the column from the lowest valve at *f*; the upper length of the pipe has a spout *i*, at which the water is delivered.

Steven's forcing pump to raise water from deep wells.

M is a second spout, fixed into the pipe lower than the former; it has a screw, by which it can be united to a tube, or leather pipe, to convey the water to a distance; or by means of a jet, or branch pipe, to throw it in the manner of a fire-engine; in this case the upper spout *i* must be stopped up, by a screw-plug or cap; and there is a copper air-tight vessel H, situated at the top of the pipe F, to equalize the pulsative motion of the water, as thrown by the pump.

k is a bracket fixed to the pipe F, and projecting over the centre of the pump, where it has a hole to receive the pump-rod *h*, and guide it steadily in its motion up and down, that it may not wear the stuffing-box away on one side. As the wooden tubes of which the forcing pump F is composed, may be made from waste or crooked timber, there is a great difference between the low price of such, and that of the straight trees necessary for common pumps.

A wooden plug may be chained to the pump near the spouts M and *i*, so as to be ready to stop the spout which is not wanted.

It is best to place the valve *f*, above the level of the water in the well.

A pump having been constructed in the manner above described, the whole expense of it was £25, and it raised the water 66 feet high. The bore of the lower part of the pump-tree was four inches. The lower part of the rod, which passes through the stuffing-box, was made of brass; the elbow and upper pump-trees were of a two-inch bore. Any kind of wood may be used for this part. Beech pump-trees have been known to last sixty years and upwards.

Method of saving Lockage Water, on Canals, Docks, and Navigations.

For this invention, a patent was taken out, the specification of which is dated, April 14, 1813.

First, To elucidate the nature of it, and the principle on which it is founded, let there be two vessels, fig. 1, plate XLVII, *a b c d*, and *e f g h*, equal, or nearly equal, in their horizontal extent, having a free communication with each other, by means of a conduit *s*, and both containing water, to one and the same level *i k*; and let the depth of the vessel *e f g h*, below the level *i k*, be at least equal to the altitude of the vessel *a b c d*, above the same level. Again, let there be two ponds of water, *l* and *m*, level with *i k* and *a b e f* respectively, each pond being of such a horizontal extent as that its surface shall not be sensibly lowered by withdrawing from it so much water as would fill either of the vessels *a b c d*, or *e f g h*, from the level *i k*, to the level *a b e f*. Then let there be placed and fitted, in the vessel *e f g h*, and immediately over and upon the surface of the water therein contained, a double piston, that is to say, two pistons *n* and *o*, firmly connected by a bar at *p*, at a distance equal, or nearly equal, to the intervals between the levels *i k* and *a b e f*: and further, let there be two conduits, *q* and *r*, communicating between the ponds *l* and *m*, and the vessel *e f g h*, whenever, and only when, the pistons are depressed below the position exhibited in this figure.

Fig. 2. Here the aforesaid pistons are represented somewhat depressed, say, for example, one foot; the water has consequently *risen* one foot, or nearly so, in the vessel *a b c d*; the water in that vessel is consequently about two feet *above* the level of the lower piston, and therefore causes an upward pressure against the under side of the said piston, about equal to the weight of a column of water two feet in height; but as the pistons have each descended about one foot, two separate feet of water have been admitted into the vessel *e f g h*, from the ponds *l* and *m*, that is to say, about one foot of water has been admitted over and upon each of the pistons, the gravitation of which water equals, or nearly equals, the aforesaid upward pressure. It is obvious that a similar counterpoising operation of the water must take place at all stages of the elevation or depression of the water in the vessel *a b c d*, between

the levels *i k* and *a b e f*, and therefore, that the pistons may be moved upwards and downwards, or downwards and upwards, the water in the vessel *a b c d* being thereby elevated and depressed to all levels between the levels *i k* and *a b e f*, by an *average* force no greater than is sufficient to overcome the friction of the said pistons against the circumference of the vessel *e f g h*, and the *vis inertiæ* of the matters that are moved. The expression *average* force is used, because there must be alternately added to, and subtracted from, the force necessary to overcome the said friction and *vis inertiæ*, a power equal to the weight of the pistons, otherwise the gravitation of the pistons themselves will accelerate the descending, and will retard the ascending motions of the said pistons. This contrivance is manifestly founded on the following law of statics, applied by the patentee to heavy fluids in preference to solids, and also in preference to solids and fluids in conjunction, viz. that heavy bodies may be made to ascend and descend in conjunction by a power no greater than is necessary to overcome friction and *vis inertiæ*, provided the common centre of gravity of those bodies does not move upwards or downwards.

Secondly, Having explained the principles which form the basis of his invention, the Patentee proceeds to describe what he conceives to be the best method of bringing those principles into action, so as to effect the purposes for which a patent has been granted to him. Suppose, for instance, it be required to construct a lock of a canal, dock, or navigation, upon the principle of this invention, capable of passing vessels with the loss of any assigned quantity of water, but say, for example, with the loss of one-eighth of a lock of water, in what is commonly called a *double operation*.

Fig. 3. Let a lock, *a a a a*, be built in the manner now common and usual, with the exception of an aperture, to be formed in one of its side, or in the bottom of it. On one side of the lock, form a circular aperture *b b b b*, nearly equal to the lock in its horizontal extent, and deeper below the surface of the lowest pond of the canal, dock, or navigation, contiguous to the said lock, than that surface is below the surface of the highest pond of the canal, dock, or navigation, contiguous to the said lock. And as the side walls of locks are generally, for the purpose of increasing their stability, made to decline upwards from each other, so as to cause the locks to contain more water in any given height of the upper part, than is contained in the same given height of the

lower part, the Patentee generally makes the horizontal extent of the upper part of the reservoir to diminish, just as much as the horizontal extent of the upper part of the lock increases, so that the horizontal extents of the lock and of the reservoir, taken together, are the same, or nearly the same, at all levels, Let a strong verticle shaft or spindle, *c c*, be erected in the centre of the said reservoir; then extend from an aperture formed in the bottom, or in the circumference of the reservoir near the bottom, a conduit *d d d d*, to the aperture formed in the side, or in the bottom of the said lock. Then extend conduits, *e e e e*, from the lowest pond, and let them terminate near to opposite parts of the circumference of the said reservoir; and extend other conduits, *f f f f*, from the highest pond, and terminate them near to other opposite parts of the circumference of the said reservoir. Having effected these objects, the Patentee proceeds to build a vessel, of the form and proportions exhibited in fig. 4; which vessel he generally constructs with the materials and after the manner of workmanship used by back-makers, in making the immense backs used in large breweries.

Fig. 4. The horizontal extent of the vessel, of which plans and sections are exhibited in this figure, is such, that if that extent, minus the extent of the conical aperture *d*, in the centre, be multiplied by the interval between the levels of the aforesaid highest and lowest ponds, minus the thickness of the upper floor of the said vessel, the *product* will be equal, or nearly equal to the product of the horizontal extent of the lock, together with the horizontal extent of the conical aperture in the said vessel, and the horizontal extent of the space, (all taken at the same level,) that will remain between the circumference of the said vessel and the circumference of the said reservoir, multiplied by seven-eighths of the interval between the aforesaid highest and lowest ponds. The distance between the upper surfaces of the two floors is equal, or nearly equal, to the greatest interval that ever occurs between the highest and lowest ponds, and the distance between the upper floor and the top of the vessel is of similar extent. The upper (or lower) diameter of the said vessel is so much greater than the lower (or upper) diameter, as will allow a sufficient draught for the circumscribing hoops, and the conical aperture in the centre of the said vessel is to subtract from the area and contents of the said vessel a space equal, or nearly so, to the addition which is made to the area and contents of the said vessel, in consequence of the increase to its upper (or lower)

diameter, so that the horizontal extent of the said vessel, exclusive of the said aperture, will be equal, or nearly equal, at all levels. The upper-siphon pans *a a*, are to be filled with water, as are the lower siphon-pans *b b*; and the lower floor is to be covered with water so high, as that the distance between the surface of that water, and the upper surface of the upper floor, shall be equal to the present interval between the aforesaid highest and lowest ponds. The weight of the said vessel, together with the weight of the said water, is to be such, as that when the said vessel shall be immersed in water, to the depth of the surface of the water on the lower floor, its unbalanced gravitation shall be equal, or nearly equal, to the weight of one-eighth of a lock of water. The space occupied by the materials of which the circumference of the said vessels, and the circumference of the siphon-holes *c c*, and upper siphon-pans, are composed, together with the space inclosed by the said siphon-holes and siphon-pans, is so proportioned as that if the said vessel be immersed in water to the depth of seven-eighths of the interval between the highest and lowest ponds, above the upper floor, and the space between the upper and lower floors of the said vessel be filled with water, the other parts of the said vessel (exclusive of the siphon-holes) being also filled with water to a weight above the upper floor, equal to the interval between the aforesaid highest and lowest ponds, minus the thickness of the aforesaid upper floor, that then the weight of the said vessel, together with the weight of all the water therein contained, shall be equal, or nearly equal, to the weight of the water displaced by the said vessel. This vessel may be called a double floating cistern.

Fig. 5. The Patentee then constructs four siphons, of the forms and proportions represented by this figure; which siphons will hereinafter appear to be used to form communications between the waters contained in the aforesaid upper and lower conduits, and the waters contained in the aforesaid upper and lower siphon-pans of the double floating cistorn, the two larger siphons being used to communicate between the lower conduits and lower siphon-pans, and the two smaller siphons to communicate between the upper conduits and upper siphon-pans. These siphons are best made of iron, cast in three pieces; the joints being rendered air-tight by means of a contrivance invented by Earl Stanhope, and commonly called the Stanhope ponds.

Fig. 6. Thirdly.—Having formed and constructed the several parts of the said invention, the arrangement of them

is made in the order exhibited in the two following figures; the first of which consists of a plan, or bird's-eye view of the lock, the reservoir, the highest and the lowest ponds, the upper and lower conduits, the double floating cistern placed within the reservoir; the larger siphons *a a*, filled with water, and communicating between the lower conduits and lower siphon-pans, and the smaller siphons *b b*, filled with water, and communicating between the upper conduits and upper siphon-pans.

Note.—The difference of the shading in this and all the following figures, is intended to designate and distinguish the waters, and communications between the waters, contained 1st, in the lock and in the reservoir; 2dly, in the lowest pond, lower conduits, lower siphon-pans, and in the lower part of the double floating cistern; and, 3dly, in the highest pond, upper conduits, siphon-pans, and upper part of the double floating cistern.

Fig. 7. This figure exhibits a vertical section through the line *c c*, on the preceding figure. Here the water in the lock is represented level with the lowest pond, the upper surface of the upper floor of the double floating cistern level with the highest pond, and the lower part of the said double floating cistern filled with water (communicating by means of the larger siphons with the lower conduit) to the level of the lowest pond. Now the unbalanced gravitation of the double floating cistern being equal, or nearly equal, to the weight of one eighth of a lock of water, the said double floating cistern is prevented from descending (when its descent is not wanted) by affixing it to the aforesaid vertical shaft, by some common mechanical contrivance, and it is here intended to be understood as being so fixed.

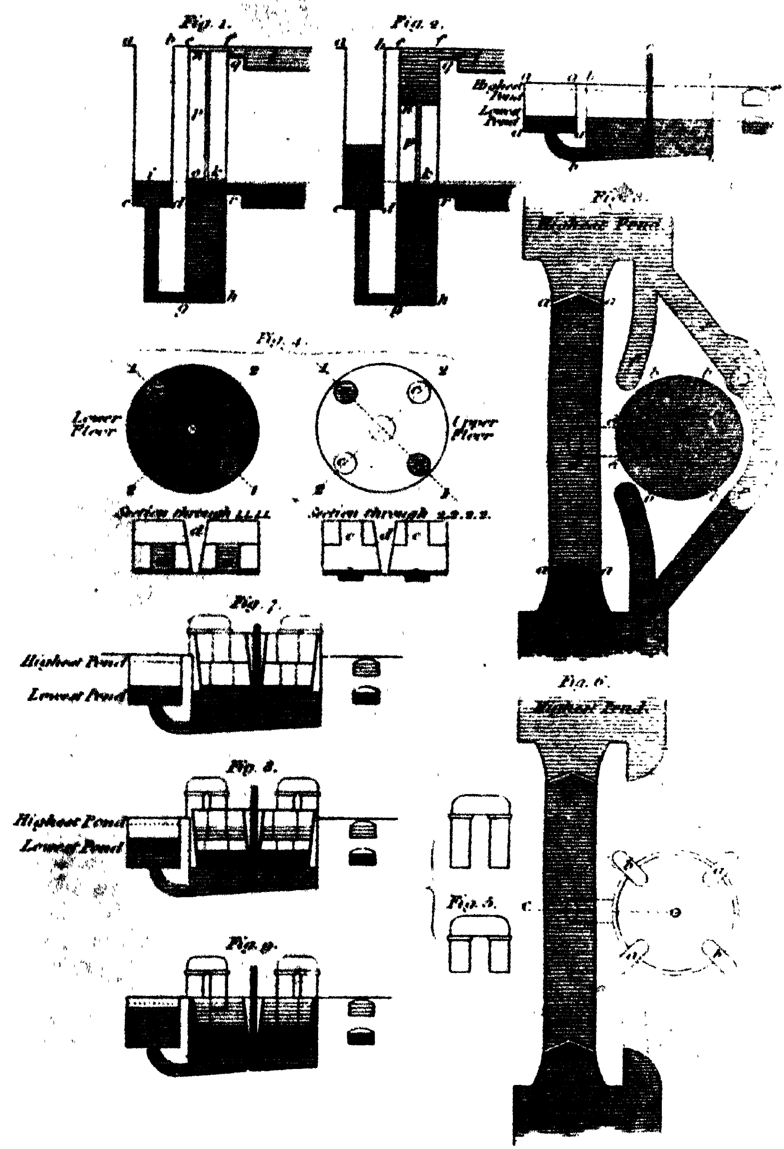
Fig. 8. Fourthly.—The said invention operates by unfixing the said double floating cistern; and in this figure the double floating cistern is supposed to have been unfixed from the aforesaid vertical shaft, and is represented as having descended through half the interval between the highest and lowest ponds, minus half the thickness of the upper floor of the said double floating cistern. The water has consequently risen in the lock seven-sixteenths of the interval between the aforesaid highest and lowest ponds. The lower part of the double floating cistern has been filled by the larger siphons from the lower conduits to the level of the lower pond. The upper part of the double floating cistern has been filled by the smaller siphons from the upper conduits to the level of the

upper pond, and the double floating cistern has lost half, or nearly half, of its unbalanced gravitation, or descending force.

Fig. 9. And in this figure the double floating cistern is represented to have descended through double the space passed through in the preceding example. The water in the lock has risen to the height of seven-eighths of the interval between the aforesaid highest and lowest ponds. The upper and lower parts of the said double floating cistern are filled by water conveyed through the siphons from the upper and lower conduits, and the double floating cistern has lost the whole, or nearly the whole, of its unbalanced gravitation or descending force. The double floating cistern is now again affixed to the vertical shaft, or spindle, and the lock filled to the level of the highest pond, from the water of that pond, the water in the lock preponderates one-eighth of a lock, or nearly so, over the double floating cistern; then the double floating cistern is to be unfixed from the said vertical shaft, the water in the lock will then fall by its superior gravitation through seven eighths of the interval between the highest and lowest ponds, the double floating cistern at the same time rising, and returning the water contained in it, to the highest and lowest ponds, and then the one-eighth of a lock of water remaining in the lock, will balance the gravitation of the said double floating cistern; but by fixing the double floating cistern to the vertical shaft, and letting the one-eighth of a lock of water, now in the lock, pass out therefrom to the lowest pond, the double floating cistern will regain its original prepondering power, and being again loosed from the vertical shaft, will descend as before described. Thus, by means of the loss of one-eighth of a lock of water, the surface of the water in the lock may be alternately elevated and depressed at pleasure, and thus, by causing vessels to take advantage, in the usual manner, of the elevation and depression of the water in the said lock, those vessels may be enabled to pass through the said lock with the loss of one-eighth of a lock of water only, even if the double operation, of filling and emptying the said lock, be necessary to the passage of each vessel.

Fifthly.—The Patentee having described the principles upon which the invention acts, and also what he conceives to be the best manner of adapting the same to the construction of a lock capable of preventing the loss of seven-eighths of the water now generally lost in lockage, it is manifest from the description, that by making proportional variations, in the proportions of the parts of the invention, that the same may

...usby's Method of saving the Lockage Water of Canals &c



Published by Henry Fisher Caxton, London 182?

be applied to preserve any other quantity, less than the whole quantity of the water which is now lost when vessels pass locks of canals, docks, or navigations. And again it is manifest, that by making the double floating cistern equal in horizontal extent, to the horizontal extent of the lock, added to the horizontal extent of the aforesaid conical aperture, and also added to the horizontal extent of the space intervening between the circumferences of the double floating cistern and the reservoir: further, by making the said double floating cistern buoyant in the water of the reservoir, and by applying a mechanical or statical compensation, equal to the weight of a body of water sufficient to fill the space occupied by materials, by the siphon-holes and upper siphon-pans, (which space cannot be further occupied by water,) the invention may be made to operate by a mechanical or other force, only sufficient to overcome the *vis-inertiæ* of the double floating cistern, and of the waters which are to be moved; and in that case, the invention would enable vessels to pass locks of canals, docks, or navigations, without any loss of water. The invention may also be executed, and made to act after the manner of the double piston exemplified in figs. 1 and 2; but these and similar modifications of the invention, would not probably be advantageous.

Lastly, existing locks of canals, docks, or navigations, may be improved by accommodating and applying this invention to them in such a manner, as shall best suit the local and other adventitious circumstances of those locks; and so as to avoid any alteration of such locks, other than by piercing their sides or bottoms, so as to form a communication with the reservoir in the manner stated.

When the attention of the Patentee was originally directed towards discovering a practicable, convenient, and efficient means of preventing the immense loss of lockage-water on canals, his first step was, carefully to examine every method already before the public, and to ascertain the theoretical or practical imperfections which (with rare exceptions) have prevented them from being adopted in any of our extensive inland navigations: and this, with a view to find out what should be avoided rather than what should be imitated; for when any new invention is contemplated, it is of singular importance to know what has already failed, and thence directly, or by inference, to learn what will entirely or partially defeat the end in view; and having taken into consideration the main object of saving water, without incurring the loss of time,

the unavoidable wear and tear of the apparatus, its constant and self-preserving good order, and its capability of almost instantaneous adjustment, to meet the fluctuating circumstances of the adjacent waters, the result went to establish, in his mind, certain negative maxims, by which to examine any plan professing to accomplish the above mentioned object. By these tests he examined, and consequently rejected, many projects that occurred to him; nor did he conceive he had attained his purpose, until he had invented a method, which, in its principle, and in the practical modifications of which that principle admitted, appeared to supersede every substantial objection that could be urged against other schemes.

To enter into all the reasonings which influenced or directed his judgment, in forming the following enumeration of circumstances, which, in his opinion, it was essential to avoid, would be tedious, and he therefore confines himself to the most important.

First. The ordinary gate lock is so simple and well contrived, for the purpose of passing vessels from one level to another, that any material deviation from the common structure must almost inevitably be disadvantageous.

Secondly. The apparatus, of whatever description it may be employed to elevate and depress the water in the lock, should not operate within the lock, nor in any situation, such, as should it be out of order, or under repair, would prevent the passage of vessels in the *now* common manner; for if that circumstance be not particularly attended to, the trade of the canal will occasionally experience a total interruption.

Thirdly. The agent, that is, the power balancing or supporting the water in all its stages of elevation or depression, must not consist of solid matter; for in that case, the weight and momentum to be borne by machinery, becomes so excessively great, as to present almost insurmountable practical objections against its application.

Fourthly. Air is an improper agent, because it is subject to expansion and condensation, according to the variations of its temperature, which expansion or condensation will necessarily derange the adjustment of the apparatus, except it be prevented by confinement in closed vessels; and further, it is improper, from the extreme difficulty of forming air-tight vessels of any considerable magnitude, and from the impossibility of preserving them in that state, particularly when subjected to the violent strains which must arise from the force with which they will require to be moved; and the escape of

the air will in course derange, and if it take place for any considerable time, as, for example, a few hours only, will prevent the useful action of the apparatus.

Fifthly. It will be obviously disadvantageous, if the apparatus be not so contrived as to be capable of adjustment to the rises, and falls, of either or both of the contiguous levels.

Sixthly. Stuffing-boxes, or other close fittings, are exceptionable, because they depend upon materials and workmanship too delicate to sustain, for any considerable time, the operations of the machinery, as well as the constant action of air and water. And again, the friction arising from them, besides deteriorating, must in a considerable degree obstruct the action of the apparatus.

Seventhly. It is manifest that it will be disadvantageous if the apparatus be of such a description as shall render it liable to be deranged by a small injury, or if its action be subject to impediment from the earth, and other foreign matters, deposited by the water in which it is designed to operate.

Eighthly. It will be objectionable, if every part of the apparatus be not readily accessible to workmen, and be not so circumstanced in other respects, as to afford immediate opportunity to repair any accidental injury, otherwise a defect, perhaps trifling in itself, will in many cases render the whole apparatus useless for a time.

Lastly. It will be a material defect, if the prevailing modes of construction and workmanship, adopted in any scheme, do not assimilate themselves to some objects familiar to workmen; for if that circumstance be not constantly kept in view, the original cost, and subsequent expenses, will be materially enhanced.

These are the principal circumstances which, in the opinion of the Patentee, ought to be avoided in every plan for saving lockage-water, and which are entirely avoided in his invention; viz.

First. The common gate-lock is employed without alteration, and therefore the construction of the lock itself is not rendered a subject of experiment.

Secondly. The apparatus which effects the saving of water, does not operate within the lock; and if out of order, may be entirely separated therefrom, by means of a vertical sluice; and vessels may then be transported in the ordinary manner, while any repairs of the apparatus are proceeding.

Thirdly. The agent is not solid matter, nor is any mechanical power used or required.

Fourthly. The agent is not air, nor are any air-tight vessels used, or required; indeed it will be of little consequence if the floating cistern be not water-tight.

Fifthly. The apparatus can be instantly adjusted to every variation of the levels of the adjacent waters, the rule for effecting that purpose, being, in all cases, to keep the upper surface of the upper floor of the double floating cistern level with the highest pond when the lock is empty; and by means of a regulator, applied so as to lengthen or contract the journey of the double floating cistern, the apparatus may be worked with the loss of a smaller, or greater, quantity of water, the rapidity of the operation being proportioned to the loss of water. Thus, if the trade should be more brisk on one part of a day than on another, by expending a little more water than usual, vessels may be passed more quickly; and at another time, when the trade may be languid, the barges may be conveyed with less rapidity, and consequently more water may be saved; but at the expense of one-eighth of a lock of water, vessels may always be passed more speedily than in the common manner.

Sixthly. No stuffing-boxes, or nice fittings of any kind, are used, or required; nor is there any friction whatever, to impede the action of the apparatus.

Seventhly. The apparatus cannot be deranged by a small injury; for if an aperture, two inches in diameter, were made in any part of the double floating cistern, it would not sensibly impede its action, but would merely cause a waste of water rather greater than ordinary; and further, the operations of the apparatus cannot be affected in the smallest degree, by the sediment from the waters of the canal.

Eighthly. Every part of the apparatus is readily accessible, and is otherwise so circumstanced, that workmen can commodiously perform any repairs that may be required.

Lastly. There is no part of the apparatus that does not consist of, or is not constructed after the manner of, some well-known species of workmanship; viz.

First. The Reservoir and Conduits are formed in the earth, of brickwork or masonry.

Secondly. The siphons are literally nothing more than cast-iron pipes.

Thirdly. The Double Floating Cistern is formed after the manner of the vats used in large breweries; and to convey

a correct idea of the facility of constructing it of sufficient dimensions for a large lock, it may not be irrelevant to observe, that there is now in Meux's brewhouse, a vat that will contain eighteen thousand barrels, each barrel being 36 gallons, amounting in the whole to 648,000 gallons, while the largest locks on the Grand Junction Canal, contain only 60,000 gallons between the contiguous levels.

Memoir on the Manufacture and Uses of Isinglass.

Every author who mentions isinglass, observes, that it is made from fish found in the Danube, and in the rivers of Russia. Willoughby and others inform us, that it is made of the sound of the Beluga; Newman, that it is made of the Huso Germanorum and other fish, which he has seen frequently sold in the public markets of Vienna. These circumstances make it appear the more extraordinary, that a perfect account of the manufacture of such an essential article of commerce should remain so long unrevealed. As a proof of the mistaken notions which have arisen on the subject, it may be observed, that Pomet directs it to be prepared by boiling the sinewy parts of fish in water, then cutting up and fashioning the jelly thus obtained, till it receives the form of the isinglass of commerce. But experiments prove, that glue, not isinglass, is the result of every process of this kind; real isinglass has a fibrous texture, which, if it be dissolved in hot water, can never be recovered. Our author having made many experiments on isinglass, and even undertaken a journey to Russia, to develope its manufacture, at length established the fact, that fish from which it may be obtained, are plentifully procurable in the British fisheries, and that the rivers and lakes of Canada abound with fish that yield it of the finest quality.

If glue be dissolved in a sub-acid fluid, such as stale beer, and mixed with fermented liquors, it forms with them a mucilaginous liquor, like diluted gum-water, and instead of clarifying them, increases both their tenacity and turbidness; but if isinglass be dissolved and added to fermented liquors in a similar manner, it forms the best composition known for fining such liquors. Here is observable a very important difference in the action of glue and isinglass, and the due consideration of it

laid open the real nature of the latter. If what is commercially termed long or short stapled isinglass, be steeped a few hours in fair cold water, the entwisted membranes will expand, and re-assume their original beautiful hue, and by a dextrous address, may be perfectly unfolded. Thus we find that isinglass is actually nothing more than certain membraneous parts of fishes, divested of their native mucosity, artfully rolled and twisted, and dried in the open air.

The sounds or air-bladders of fresh-water fish, in general, are preferred for this purpose, as being the most transparent, flexible, delicate substances. These constitute the finest sorts of isinglass; those called book and ordinary staple, are made of the intestines, and probably the peritonæum of the fish. The Beluga yields the greatest quantity, as being the largest and most plentiful fish in the rivers of Russia, but the sounds of all fresh-water fish yield, more or less, fine isinglass, particularly the smaller sorts, found in prodigious quantities in the Caspian sea, and several hundred miles beyond Astracan, in the Wolga, Yaik, Don, and even as far as Siberia, where it is called *kle* or *kla* by the natives, which implies a glutinous matter; it is the basis of the Russian glue, which is preferred to all other kinds for its strength.

The sounds, which yield the finest isinglass, consist of parallel fibres, and are easily rent longitudinally; but the ordinary sorts are found composed of double membranes, whose fibres cross each other obliquely, resembling the coats of a bladder. Hence the former are more readily pervaded and divided by sub-acid liquors; but the latter having a peculiar kind of interwoven texture, are with great difficulty torn asunder, and long resist the power of the same menstruum; yet, when duly resolved, are found to act with equal energy in clarifying liquors.

Isinglass receives its different shapes in the following manner:—The parts of which it is composed, particularly the sounds, are taken from the fish while sweet and fresh, slit open, washed from their slimy *sordes*, divested of every thin membrane which envelopes the sound, and then exposed to stiffen a little in the air. In this state, they are formed into rolls about the thickness of a finger, and in length according to the intended size of the staple; a thin membrane is generally selected for the centre of the roll, round which the rest are folded alternately, and about half an inch of each extremity of the roll is turned inwards. The due dimensions being thus obtained, the two ends of what is called short staple are

pinned together with a small wooden peg; the middle of the roll is then pressed a little downwards, which gives it the resemblance of a heart shape, and thus it is laid on boards, or hung up in the air to dry. The sounds which compose the long staple, are larger than the former; but the operator lengthens this sort at pleasure, by interfolding the ends of one or more pieces of the sound with each other. The extremities are fastened with a peg, like the former; but the middle part of the roll is bent more considerably downwards; and, in order to preserve the shape of the three obtuse angles thus formed, a piece of round stick, about a quarter of an inch in diameter, is fastened in each angle with small wooden pegs, in the same manner as the ends. In this state it is permitted to dry long enough to retain its form, when the pegs and sticks are taken out, and the drying completed. Lastly, the pieces of isinglass are colligated in rows, by running packthread through the peg-holes, for the convenience of package and exportation.

The membranes of the book isinglass, being thick and refractory, will not admit a similar formation with the preceding: the pieces, therefore, after their sides are folded inwardly, are bent in the centre, in such a manner that the opposite sides resemble the cover of a book, whence its name; a peg being run across the middle, fastens the sides together, and thus it is dried like the former. This sort is interleaved, and the pegs run across the ends, the better to prevent its unfolding.

That called cake isinglass is formed of the bits and fragments of the staple sorts, put into a flat metalline pan, with a very little water, and heated just enough to make the parts cohere like a pancake, when it is dried; but frequently it is overheated, and pieces to which this has happened, are useless in the business of fining. Experience has taught the consumers to reject them.

Isinglass is best made in the summer, as frost gives it a disagreeable colour, deprives it of weight, and impairs its gelatinous principles. Its fashionable forms are unnecessary, and frequently injurious to its native qualities. It is common to find oily putrid matter, and *exuviæ* of insects, between the implicated membranes, which, through the inattention of the cellarman, often contaminate wines and malt-liquors in the art of clarification. These peculiar shapes might probably be introduced originally with a view to conceal the real substance of isinglass, and preserve the monopoly; but for this purpese,

they are now useless, and in its native state, isinglass might be afforded rather cheaper than at present, and its efficacy would be increased rather than diminished. Although a preference is given to fresh-water fish, as affording isinglass of the very finest quality, and therefore the interior of Canada may be the most proper country, to which we may look for vast supplies of this substance, yet the manufacture of it may be rendered a valuable appendage to the marine fisheries, as will appear by the following details:

The sounds of cod and ling bear a great analogy to those of the *accipenser* genus of Linnæus and Artedi, and are in general so well known as to require no particular description. The Newfoundland and Iceland fishermen split open the fish as soon as taken, and throw the back-bones, with the sounds annexed, in a heap; but, previous to incipient putrefaction, the sounds are cut out, washed from their slime, and salted for use. In cutting out the sounds, the intercostal parts are left behind, which are much the best; the Iceland fishermen are so sensible of this, that they beat the bone upon a block with a thick stick, till the pockets, as they term them, come out easily, and thus preserve the sound entire. If the sounds have been cured with salt, that must be dissolved by steeping them in water, before they are prepared for isinglass: the fresh sound must then be laid upon a block of wood, whose surface is a little elliptical, to the end of which a small hair-brush is nailed, and with a saw-knife, the membranes on each side of the sound must be scraped off. The knife is rubbed upon the brush occasionally to clear its teeth; the pockets are cut open with scissors, and perfectly cleansed of the mucous matter with a coarse cloth: the sounds are afterwards washed a few minutes in lime-water, in order to absorb their oily principle, and lastly in clear water. They are then laid upon nets to dry in the air; but, if intended to resemble foreign isinglass, the sounds of cod will only admit of that called book, but those of ling both shapes. The thicker the sounds are, the better the isinglass, colour excepted; but that is immaterial to the brewer, who is its chief consumer.

This isinglass resolves into fining, like the other sorts, in sub-acid liquors, as stale beer, cider, old hock, &c. and in equal quantities produces similar effects upon turbid liquors, except that it falls more speedily and closely to the bottom of the vessel; but foreign isinglass retains the consistency of fining preferably in warm weather, owing to the greater tenacity of its native mucilage. Vegetable acids only should be employed in fining.

It has long been a prevalent opinion, that sturgeon, on account of its cartilagious nature, would yield great quantities of isinglass; but on examination, no part of this fish, except the inner coat of the sound, promised the least success. This being full of *rugæ*, adheres so firmly to the external membrane, which is useless, that the labour of separating them supersedes the advantage. The intestines, however, which in the larger fish extends several yards in length, being cleansed from their mucus, and dried, were found surprisingly strong and elastic, resembling cords made with the intestines of other animals, commonly called catgut, and from some trials, promised superior advantages, when applied to mechanical operations, in which catgut is employed.

We subjoin the following method of forming a very excellent glue with isinglass:—Take an ounce of isinglass, pound it in a mortar, and when it is in small pieces, put the whole into a half-pint phial; fill the phial with common gin, put a cork into it with a notch cut in one side, that the vapour may escape; place it near the fire, and shake it often till the isinglass is dissolved. Strain off the whole, and keep it in a clean phial well corked for use. This glue will be good for many years, and is a very convenient preparation for a number of purposes. By warming, it becomes fluid and fit for use. It is extremely suitable for taking impressions of medals, and it may be coloured by mixing pigments with it, or ornamented by gilding. The glue, if mixed with equal proportions of good drying oil, forms a cement for joining earthenware, china, &c. and for articles which have to bear exposure to the weather; the cement thus prepared and used should be dried in an oven. The glue, with two parts of boiling water, mixed up with emery and lampblack, forms, when two or three coats are laid upon stiff paper, the slate-paper employed for pocket-books.

Method of sawing Cast-iron, with almost the same facility as Wood.

When the sawing of hot cast-iron was first announced, it was treated as an idle notion; but it is now practised in a great number of workshops, and proves very advantageous. It is not known when it was first adopted; Pictet observed a workman practising it several years ago; but Dufaud, director of the iron-works at Montalire near Creil, in France, appears to be the first who wrote on the subject, and he received his instructions, relative to the process, from D'Arcet.

It is well know to artisans, that the sawing of cold cast-iron is not only very tedious, but very destructive to the tool; the outside or crust of the cast-iron is generally so hard that the saw is blunted at the first stroke, and even the interior often contains particles which are broken out rather than cut through. A mode therefore of dividing the largest masses of it, may certainly be regarded as of considerable importance in the arts.

The sawing of cast-iron may be easily accomplished by attending to the following instructions:

1. The iron should be uniformly heated to a cherry red, and not higher, as when it approaches to a state of fusion, it becomes more tough, and clogs the saw. A furnace is more suitable than a forge, for heating the iron, on account of its heating it more uniformly.

2. A long joiner's saw should be employed, with its teeth set fine, to diminish the resistance. It should be moved quickly, and through its whole length, as in sawing wood. When the cut is made, it should be instantly plunged into water, to prevent as much as possible, any diminution of its temper.

To prevent the iron from breaking off, when partly cut through, it should be supported in its whole length.

4. When a considerable thickness of iron is to be cut through, two saws of the same size should be in readiness, that they may be used and cooled alternately; and their sharpness will be found to sustain very little injury by the operation.

6. The place at which the saw is to enter, may be marked with red lead before the iron is heated.

Preparation of pure Olive Oil for Chronometers.

Having several times furnished persons with olive oil; prepared for chronometers in a peculiar manner, and having received very favourable testimonials of its superior value, the inventor determined to publish his process for this purpose, and has accordingly given the following account of it:—

Put a quantity of the best olive oil into a phial with two or three times as much water, so that the phial may be about half full. Shake the phial briskly for a little time, turn the cork downwards, and let most part of the water flow out between the side of the cork and the neck of the phial. Thus the oil must be washed five or six times.—After the last quantity of water has been drawn off, what remains is a mixture of water, oil, and mucilage. To separate these from each other, put the phial into hot water for three or four minutes, and most part of the water will fall to the bottom, which must be drawn off as before.

The oil must then be poured into a smaller phial, which being nearly full, must be well corked, set in a cool place, and suffered to stand undisturbed for three or four months, or until all the water shall have subsided, with the mucilage on the top of it, and the oil, perfectly transparent, swimming on the top of the mucilage. When *time* has thus completed the operation, the pure oil must be poured off into very small phials, and kept in a cool place, well corked, to preserve it from the air.

A chronometer which had been taken in a voyage to India and back, and had been in use about sixteen months, vibrated as freely as at first, the oil which had been prepared by the above process being still in excellent condition ; and all other trials of the oil thus purified proved equally satisfactory.

Hydraulic Machine, set in Motion by the Re-action of Water.

Suppose a cylinder AB, plate XXXIII, fig. 5, terminating in a box, and moveable about an axis DE, or moveable on a pivot at D, and in a collar towards the upper part A. Suppose a hole to be opened at C, if the interior be entirely filled with water, the fluid issuing out at C, from the re-action of the column of water on the side opposite to C, will cause the whole to move round. At F there is another hole on the opposite side of the box. There may be another box, with similar holes, crossing the box CF at right angles. It is obvious, that if a stream of water constantly enter at E, sufficient to keep the cylinder and boxes full, the whole will turn round, and may be made to put in motion any apparatus, proportional to the force with which it moves.

Where a plentiful fall of water is at command, this mode of rendering it useful as a first mover, may be sufficient for the purpose, and less expensive than a wheel. It is evident, that the trunk AB, need not be a cylinder, but a rectangular case, consisting of four boards fastened together in the manner of a wooden spout, only if the length be considerable, it will be proper to bind the lower part of it with iron. If the trunk AB is supported at the upper end by a collar at A, the mouth will be entirely open for the influx of the water, but the friction will be greater than if it merely turned on a pivot at that end as well as the lower end, and perhaps the expense will be increased. If a pivot at E, be therefore adopted, it may be caused to interfere very little with the influx of the water, by supporting it with two cast-iron crosses, in the manner shown at H, and sinking the uppermost of these crosses below the aperture or mouth A. By making the crosses deep, in their vertical dimensions, they may be made so as to present a very narrow edge on their upper surfaces, and yet possess any degree of strength that can be required.

Account of a cheap Method of preparing Potash, with Observations.

The Agricultural Society of Manchester has long recommended the making of reservoirs for the water which flows from dunghills in farm-yards. This water is strongly impregnated with the salts and putrid matter of the dunghill, and by stagnation, it acquires a much higher degree of putrescence, and probably becomes proportionably more replete with salts. When thus collected and improved, it is pumped into a hogshead, which being drawn upon a sledge, or small cart, is conveyed into the meadows, for the purpose of sprinkling them with this rich manure. This important improvement in rural economy, has not probably been extended much beyond the district of the society alluded to: and it seems to be unknown to one of the latest and most intelligent writers on husbandry; for Lord Kaims, in a recent work of his on the subject, has not even mentioned it.

But these reservoirs may be applied to a purpose still more subservient to public utility than that above described. This has been demonstrated by Josiah Birch, a gentleman who carries on an extensive manufactory, and bleaches his own yarn, who about six months ago was induced, by a happy turn of thought, to try whether the dunghill water might not be converted into potashes. He accordingly evaporated a large quantity of it, and burnt the residuum in an oven; the product of which so perfectly answered his expectations, that he has ever since continued to prepare these ashes, and to employ them in the operations of bucking. A stranger to that narrowness of spirit, which seeks the concealment of a lucrative discovery, he furnished the following account for the Royal Society:

"The quantity of muck-water used, was twenty-four wine-pipes full, which employed a man and two horses two days, to cart it from the pump to the pan wherein it was boiled; but this expense I shall now save, as I shall lay a sough of brick, which will convey it from the pump to the boiler. The coals used to boil and burn it were one hundred and twenty baskets; and I suppose each basket weighs six-score pounds or upwards. One man was occupied three weeks in boiling and burning. The quantity of ashes made was 9 *cwt.* 1 *qr.* 12 *lbs.* well worth, at the present price of ashes, two guineas per hundred.

"9 *cwt.* 1*qr.* 12*lbs.* at 42*s.* per cwt.				.£19	13*s*	0*d*
A man and two horses, two days, at 6*s* per day	£0	12*s*	0*d*			
120 baskets of coals, at 5*d* per basket	2	10	0			
A man's wages for three weeks . .	1	7	0			
				4	9	0
				15	4	0

"The profit, therefore, amounts to £15 4s, deducting only a trifle for the pan and oven." The pan consisted of iron plates, turned up a little at the edges, to which were screwed planks of wood, to make it about twenty inches deep.

Since the period at which the above was written, a great difference has arisen in the price of labour, but the price of ashes has also increased, and this, with the saving above pointed out in the process originally adopted, will amount to more than a counterbalance. Hence the profits arising from this preparation of potash, may be considered as sufficiently evinced by the foregoing estimate; and they may undoubtedly admit of increase by future improvements. In the spring and summer seasons, probably, the evaporation might be carried on without the aid of fire, by conveying the dunghill water from the reservoir through proper sluices into shallow troughs or ponds, of such extent as to afford a sufficient surface for the action of the sun and wind. These might be covered in rainy weather with awnings of canvass, painted on the outside black, and white on the inside; the former with a view to absorb, the latter to reflect the rays of light.

The potash prepared by this process is of a grayish white appearance; deliquesces a little in moist air, but if kept in a dry room, near the fire, acquires a powdery surface. It is hard, and of a spongy texture when broken, with many small crystals in its substance. The colour of its internal parts is dusky and variegated. To the taste it is acrid, saline, and sulphurous. It emits no smell of volatile alkali, either in a solid form, dissolved, or when added to lime-water; neither does it communicate the sapphire colour to a solution of sulphate of copper. Silver is quickly tinged black by it. Ten grains of this potash require eleven drops of weak sulphuric acid to saturate them. The like quantity of salt of tartar required of the same acid, twenty-four drops: a strong effervescence occurred in both mixtures: from the former a

sulphurous vapour was exhaled. A tea-spoon-full of the sirup of violets, diluted with an ounce of water, was changed into a bright green colour by five grains of the salt of tartar; but ten grains of this potash were necessary to produce the same hue in a similar mixture. Half an ounce of the potash dissolved entirely in half a pint of hot water; but when the liquor was cold, a large purple sediment subsided to the bottom; and it was found, that this sediment amounted to about two-thirds of the whole quantity of ashes used.

The following general observations may be offered on the facts which have been advanced:

1. This potash is a true fixed vegetable alkali, and a product of putrefaction, which appears to have been hitherto unnoticed. Macquer even in express terms asserts, that "all vegetables, not excepting those which in their natural state furnish ashes containing much fixed alkali, when burnt, after their acid has been altered by a complete putrefaction, leave ashes entirely free from alkali."

2. The quantity of alkali contained in this potash, may, with some probability, be estimated at one-third of its weight; whereas the white Muscovy ashes are stated by Home, in his essay on bleaching, to yield only one-eighth part. Of its impurities, sulphur is the most injurious to its bleaching powers, and should, in the preparation of it, be carefully separated. A longer continued, and more gentle calcination, in a furnace supplied with a sufficient current of air, might perhaps answer this end. But the most effectual method would be to lixiviate the salt with pure water, after a moderate fusion, and then to evaporate them slowly to dryness. It must, however, be remarked, that in thus treating the potash, both the action of fire, and the solution in water, convert into earth a portion of the alkaline salt.

3. No quicklime appears to be contained in this potash; for a solution of it, poured from its sediment, remained clear, though long exposed to the air. Nor did it acquire any milkiness from being blown into from the lungs; but perhaps the addition of this caustic substance would increase its activity and value, when applied in soap-boiling and other arts: for the Russian potash is more pungent to the taste, saturates a larger proportion of acid, and dissolves oils more powerfully than the pure alkaline salts: and Dr. Home has proved, that these qualities depend on a large admixture of quicklime.

4. It would be worthy of trial, to ascertain whether the large purple sediment, which subsides when this potash is lixiviated, might not be applied to the manufacture of Prussian blue; or used in the manner recommended by Macquer for dyeing wool and silk.

5. The farmer, though he live at a distance from the manufactures in which potash is employed, may yet find his account in preparing it from dunghill water; for it will furnish him with a top dressing for his garden and land, of great fertilizing powers. But if fuel be dear where he resides, and conveniences for combustion be wanting, the simple evaporation of water may suffice, and the putrid ley, thus reduced to a solid form, will prove to be a rich manure.

The Author of this memoir practised the following method of making a compost of dunghill water, at Hart Hill, about three miles from Manchester: The weeds and rakings of the garden, the dressings of the fields, the leaves blown from the trees, and other refuse matters, were put together near the reservoir, out of which the matter was occasionally pumped, and scattered over the heap. So strong a ferment, almost instantly excites putrefaction; and these vegetable substances are soon converted into a fertile mould, which retaining the salts and oils of the dunghill-water, suffers the superfluous moisture to exhale into the air, or to percolate through it. He found by experience, that the compost thus prepared, is laid on the meadows at less expense, and that it is more efficacious and durable in its operation than the sprinkling, which, at stated times, they formerly received: for the land, though good, and in fine condition, is light and sandy, and the dunghill water quickly passed below the roots of the vegetables which grow upon its surface.*

A method of extracting potash from potatoe tops, has lately been announced in the public journals, as a most important discovery, and will be found in another part of this work.

An Account of a Method by which Ships that have been driven on Shore, and damaged in their Bottoms, may be safely removed to distant places for repairing.

On the shores of this island, so eminent for the extent of its commerce, there must necessarily be many shipwrecks. Every hint, therefore, by which the distress of our fellow-creatures may be alleviated, or any saving of property made to individuals in such situations, should be made known. With this view, was originally drawn up, the following account of the success which attended a method for the safe removal of ships that have been driven on shore, and damaged in their bottoms, to places, (however distant,) for repairing them.

On the first of January, 1779, in a most dreadful storm, the York East Indiaman, of eight hundred tons, homeward bound, with a pepper cargo, parted with her cables in Margate Roads, and was driven on shore, within one hundred feet of the head, and thirty feet of the side of Margate pier, then drawing twenty-two feet six inches of water, the flow of a good spring tide at that place being only fourteen feet.

On the 3rd of the same month, the Author of this essay and contrivance, went down, as a ship-builder, to assist in devising the best means to be adopted which the case admitted. He found her perfectly upright, and her shere (or side appearance) the same as when first built, but sunk to the twelve feet water-mark, fore and aft, in a bed of chalk mixed with a stiff blue clay, exactly the shape of her body below that draught of water; and from the rudder being torn from her as she struck coming on shore, and the violent agitation of the sea after her being there, her stern was so greatly injured, as to admit free access thereto, which filled her for four days equal to the flow of the tide. Having fully informed himself of her situation, and the flow of the spring tides, and being clearly of opinion that she might be again got off, he recommended, as the first necessary step, the immediate discharge of the cargo, and in the progress of that business, he found that the tide always flowed to the same height on the ship; and when the cargo was half discharged, and he knew the remaining part should not make her draw more than eighteen feet of water, and while he was observing the water at twenty-two feet six

inches by the ship's marks, she intantly lifted to seventeen feet eight inches, the water and air being before excluded by her pressure on the clay, and the atmosphere acting on her upper part equal to six hundred tons, which is the weight of water displaced at the difference of these two draughts of water.

The moment the ship lifted, it was discovered she had received more damage than was at first apprehended, her leaks being such as filled her from four to eighteen feet of water in one hour and a half. As nothing effectual was to be expected from pumping, several scuttles or holes in the ship's side were made, and valves fixed thereto, to draw off the water to the lowest ebb of the tide, to facilitate the discharge of the remaining part of the cargo; and after many attempts, an external application of sheep-skins sewed on a sail, and thrust under the bottom, succeeded in stopping the body of water from rushing so furiously into the ship. This business effected, moderate pumping was competent to keep the ship to about six feet water at low water, and by a vigorous effort, the ship could be rendered so light as (when the cargo should be all discharged) to be easily removed into deeper water. But as the external application might be disturbed by so doing, or totally removed by the agitation of the ship, it was absolutely necessary to provide some permanent security for the lives of those who were to navigate her to the river Thames. Under these circumstances, the Author recommended, as the cheapest, quickest, and the most effectual plan, to lay a deck in the hold, as low as the water could be pumped to, framed so solidly and securely, and calked so tight, as to swim the ship independent of her own leaky bottom.

In the execution of this plan, beams of fir timber, twelve inches square, were placed in the hold under every lower deck beam in the ship, as low as the water would permit; these were in two pieces, for the convenience of getting them down, and also for the better fixing them of an exact length, and well bolted together when in their places. Over these were laid long Dantzic deals, of two inches and a half in thickness, well nailed and calked. Against the ship's side, all fore and aft, was well nailed a piece of fir, twelve inches broad, six inches thick on the lower, and three inches on the upper edge, to prevent the deck from rising at the side. Over the deck, at every beam, was laid a cross piece of fir timber, six inches deep and twelve inches broad, reaching from the pillar of the hold, to the ship's side, on which the shores were to be

placed to resist the pressure of the water beneath. On each of these, and against the lower deck beam, at equal distance from the side and middle of the ship, was placed an upright shore, six inches by twelve inches, the lower end let two inches into the cross piece. From the foot of this shore to the ship's side, under the end of every lower deck beam, was placed a diagonal shore, six inches by twelve, to ease the ship's deck of part of the strain by throwing it on the side. An upright shore, of three inches by twelve, was placed from the end of every cross piece to the lower deck beams at the side; and one of three inches by twelve on the midship end of every cross piece to the lower deck beam, and nailed to the pillars in the hold. Two firm tight bulk-heads or partitions were made as near the extremes of the ship as possible. The ceiling or inside plank of the ship was very securely calked up to the lower deck, and the whole formed a complete ship with a flat bottom withinside to swim the outside leaky one; and that bottom being depressed six feet below the external water, resisted the ship's weight above it, equal to five hundred and eighty-one tons, and safely conveyed her to the dry dock at Deptford.

Shortly afterwards, the Author was desired to use the same method on a Swedish ship, stranded near Margate on the same day as the York East Indiaman, and swim her to London. The burden of this ship being about two hundred and fifty tons, the execution of the business was somewhat different to that practised with regard to the large ship; it may therefore not be improper to describe it.

The ship was materially injured; she had lost eight feet of her stern-post, and all her keel; several floor-timbers were broken, and some of the planks of her bottom, (so as to leave a hole large enough for a man to get through,) several lower deck beams were likewise broken, and all the pillars in the hold were broken and washed away. It therefore became necessary to connect, in some degree, the shattered bottom with the ship's decks not only to support the temporary deck by which she was to swim up, but to prevent the bottom from being crushed by the weight of the ship when she was put upon blocks in the dry dock: to effect which, after twelve beams of fir, six inches by twelve, were put across edgeways, one under every lower deck beam of the ship, and well fastened to the ship's side; two upright pieces were placed to each beam of six inches by twelve, securely bolted to the sides of the keelson, and scored six inches under the ship's lower

deck beams, and three inches above the beams of the temporary deck, and well fastened to each: then the deck was laid with long two-inch Dantzic deals, and well nailed and calked: the ship's inside plank was also well calked up to the lower deck. A piece of fir, of twelve inches broad, two inches thick on the upper, and four inches on the lower edge, was well nailed to the ship's side all fore and aft, and well calked on both edges, to prevent the side of the deck from leaking, or being forced up by the pressure of the water against the deck; a two-inch deal or cross-piece was laid over every beam from the ship's side to the uprights at the middle line; then, at equal distance from the side and middle line, pieces of six inches square, as long as could be got down, were put all fore and aft on both sides, scored two inches over every cross-piece, and well bolted through the cross-piece and deck, and into the fir beams. From this fore and aft piece or ribband, to the ship's side, and from it to the uprights in the middle, were placed two rows of diagonal shores, six inches square, the heels of which were securely wedged against the fore and aft piece or ribband, which afforded sufficient support to the temporary deck without any other shores. Two bulk-heads or partitions were built, as far as the foremast forward, and mizenmast aft, well planked, shored, and calked, to resist the water.

As decks laid in this manner, and in so much hurry as the time of low water requires, will of consequence leak in some degree; and as that leakage, washing from side to side, will cause the ship to lay along, a two-inch deal, twelve inches broad, was fixed edgeways, all fore and aft at the middle line, and well calked, to stop half the water on the weather or upper side, when the ship would incline either way, which not only made her stiffer under sail, but facilitated pumping out the water made by leaks in the deck.

This deck was sixty-three feet long, and twenty-three feet broad, and was laid at five feet five inches above the bottom of the keel, or four feet above the top of the floor timbers, and swam the ship at twelve feet five inches water, resisting two hundred and sixteen tons, and containing under it, one hundred and twenty-four tons of water, which, pressing against the under side of the temporary deck, acted as ballast, and brought her safely into the dry dock at Deptford, from the most dangerous situation possible, being partly within and partly without Margate pier, where she had been left by some Ramsgate-men, who had undertaken to remove her from the place where she was stranded to a safer one within Margate harbour.

Machine for drawing Bolts into and out of Ships.

The driving of copper bolts into ships, cannot, when they are of considerable length, be accomplished by the ordinary means of driving nails, without splitting or bending them. Several attempts have therefore been made to construct machines for the purpose of readily driving them home; in this and the following article we shall describe two inventions of this kind, which have been esteemed as the best yet produced. Each of them exhibits a mode of operation with which the ingenious mechanic ought to be acquainted, and he can make the election which suits his inclination. The instrument described in the subsequent article is the more simple, and perhaps the most effectual of the two, for driving bolts into ships; but it has not, like the invention now to be considered, any application except that of *driving* bolts.

The first machine we shall describe, is one for *drawing* bolts into as well as out of ships. It is easily worked, and takes up little room. It is represented by fig. 1, plate XLVIII.

AAAAAA, is the frame of the machine. B, a cylindrical tube, screwed on the inside. C, a wheel with teeth attached to the cylinder B, and turning round therewith. D, an endless screw adapted to the wheel C. E, the handle of the winch. F, the bolt in the act of being drawn out. GG, blocks to support the frame. H, a hollow piece of steel, having an outside screw on it, whose threads work within those of the cylinder B. To this piece of steel the bolt is to be securely riveted.

I, a semi-circular piece of steel, which is to be introduced into the notches on H, when a similar notch has been cut in the head of the copper bolt, which by this means is prevented from turning in H, while drawing.

K, the bolt, as prepared to receive the machine.

L, a steel bar, somewhat smaller than the bolt to be drawn in, having at one end an inside screw *a*, and at the other end an outside screw that fits the socket screw in B.

M, a section of an outside screw, having a square hole larger than the bolt.

N, a bolt ready to be drawn in; it has an outside screw at one end.

TO DRAW BOLTS OUT OF SHIPS.

The head of the bolt must be cut off, and a hole made in the timber big enough to receive the screw H, which is put over the bolt; a slit is then to be made, either by a saw or cold chisel, in the head of the bolt, to receive the key I, and which corresponds to the slit in H: the bolt head is then to be riveted as firmly as possible upon H: the cylindrical tube B, is then to be screwed upon H, by turning the whole machine round till it can be done no longer, when the endless screw is to be used by turning the winch. This commences the drawing of the bolt. If the machine is of a proper strength, and the riveting well done, the power is such as to extract the bolt or break it; but generally it will draw it out uninjured.

TO DRAW BOLTS INTO SHIPS.

It will be necessary to have a bar L, (which should be made of steel,) long enough to pass from the inside to the outside of the ship, and somewhat smaller than the copper bolt intended to be drawn in. This may be called a conductor. At one end should be an inside screw, *a*; the bolt to be drawn in should be tapped at one end to receive the screw *a*, on the conductor, and at the other end should be another screw adapted to that in the cylinder B: after which the operation is the same as drawing a bolt out, and the machine should be applied accordingly. When the bolt arrives at its destined place, it may be secured on the inside by a nut; a mode of fastening which is equal to clinching, and much more expeditious.

This machine, though only eighteen inches high, will draw bolts of any length in or out; for after the bolt has risen to the top of the tube, it will only be necessary to screw the machine back, and follow up the work with blocks of timber, as represented in the plate.

It may also be observed, that if the upper part of the hole in H be made square, and larger than the round hole as shown at M, and the head of the bolt riveted into it, it will do away the necessity for the key I, render the machine somewhat less complicated, and will perhaps prove upon the whole the most eligible mode of construction.

Method of driving Bolts into Ships.

This instrument for driving bolts into ships, consists of a tube, formed from separate pieces of cast iron, which are placed upon the heads of each other, and firmly held together by iron circles or rings over the joints of the tube. The lowest ring is pointed, to keep the tube steady upon the wood. The bolt being entered into the end of the hole bored in the wood of the ship, and completely covered by the iron tube, is driven forward within the cylinder by an iron or steel punch, placed against the head of the bolt, which punch is struck by a mall; and as the bolt goes further into the wood, parts of the tubes are unscrewed and taken off, till the bolt is driven into its place up to the head. The tubes are about five inches in circumference, and will admit a bolt of seven-eighths of an inch in diameter.

This machine is represented in plate XLVIII, figs. 2, 3, 4, and 5.

Fig. 2, A, the copper bolt, with one end entered into the wood, previous to fixing the tube.

B, a piece of timber, or ship's side, into which the bolt is intended to be driven.

Fig. 3, CCCC, the parts of the iron tube fastened together, ready to be put on the bolt A.

DDDDD, iron or brass rings with thumb-screws, placed over the joints of the tube, to hold them firmly together.

EEEEE, the thumb-screws, which keep the rings and tubes firm in their proper places.

F, two points formed on the lower ring: they are to stick into the timber, to enable the tube to be held firmly in its place.

Fig. 4. shows the separation of the parts of the tube, which is effected by slackening the thumb-screws and rings.

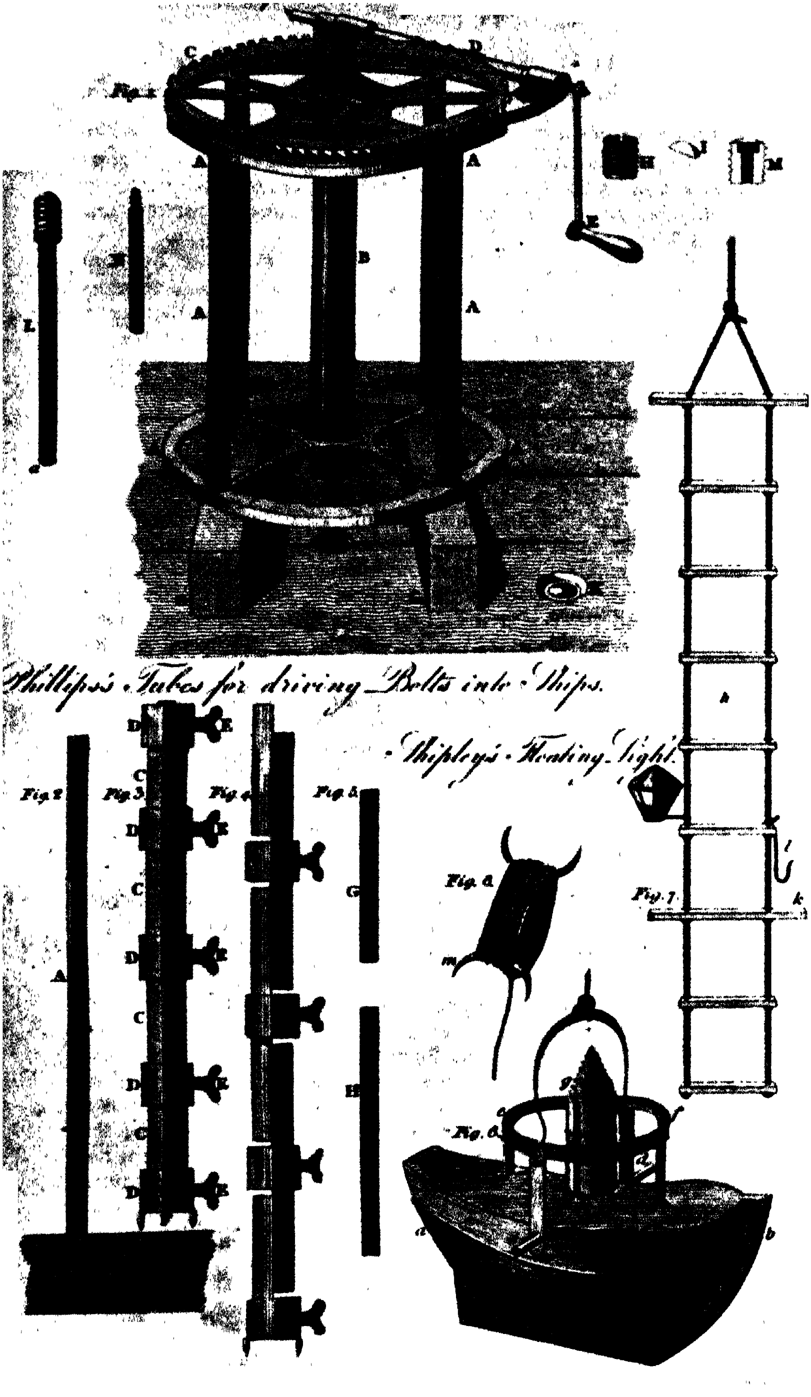
To put the parts of the tube together, slide the rings over the joints, placed as close as possible; then, by tightening the thumb-screws, the whole will be rendered firm, and the length of the tube may be continued as far as may be required.

Fig. 5, two steel punches or drifts, to be placed on the head of the copper bolt within the tube, whilst driving. The blow given upon the punch drives forward the bolt. The shortest of them, G, should be used first, and, when driven nearly to its head, should be taken out of the tube, and the longer punch, H, applied in its place.

Description of a Floating Light, calculated to save the Lives of Persons who fall overboard in the Night from a Ship.

It is proposed, in order to render this floating light useful, that it be placed every night under the care of the officers on watch; that its lamp be frequently trimmed and supplied with fresh oil, and its wick moistened with spirits of turpentine, in order that it may take fire with the least touch of a lamp or candle, and whenever the alarm is given of any of the sailors falling overboard in the night, the officer on watch may light the lamp in the lantern belonging to the float as expeditiously as possible, and let the float down by a small cord, wound upon an iron reel, into the water, till it has floated about one second of time, and the float is a little way out of the perpendicular of the small cord. He is then to secure the cord on the reel, to prevent its unwinding, and toss it overboard. The reel will sink down, and pull the line almost perpendicular, and thus it will not be liable to entangle the person when he swims to the float, who, when he has got hold of the handles of it, may move it very fast which way he will, only by striking his legs in the same manner as he does when he swims; and as the light of the lamp will be a certain guide for the person fallen overboard to find the float, so it will also direct them in the ship to find the man and float. And when the ship has tacked about, and is come to the float, then the following method is proposed to take up the man and float into the ship, viz. a lantern, with a rope ladder, may be let down by a cord from the ship, till a cross-bar below the lantern touches the water, which may be seen by them in the ship by means of the light from the bottom of the lantern, and thus the man in the water may lay hold of the cross-bar, and fix his feet on one of the steps of the rope ladder, and he may then lay hold of the iron bar or handle of the float with one hand, and hang it on the hook of the rope, above the cross-bar, which being done, the man and float may be both safely lifted into the ship.

The floating light consists of a hollow vessel in the form of a boat, made of tinned iron plate, *a b*, fig. 6, plate XLVIII, the joints of which are carefully soldered, so as to keep out the water. The boat is twenty-seven inches long, thirteen



Phillips's Tubes for driving Bolts into Ships.

Shipley's Floating Light.

broad in the middle, and twelve deep, and is sufficient to support a man in the water. From the gunwale of the boat, on each side, projects a handle *c d*, soldered fast to it for the man to hold by.

A metal ring, *e f*, is connected with the boat by four upright pieces, within which is another smaller ring, turning on pivots, fastened to the ring *e f*, in the direction of the boat's length: the internal ring supports a small lantern *g*, by an axis which passes through it, and is pivoted into the ring at each end, in the direction of the boat's breadth. By means of these rings the lantern will remain in a vertical position, independent of the boat's motion.

On the first alarm of a man falling overboard in the night, the candle is to be lighted, and the machine lowered into the sea by the rope. If the man should be at a small distance from the ship, he may, by means of the rope, be taken on board immediately on his reaching the machine; if not, the rope may be secured on the iron reel, to prevent its unwinding, and cast off, and the light will direct the man where to find it, and holding fast by the two handles, he will be supported in the water.

Fig. 7, *h* is a rope ladder, having a lantern attached to it, as well to direct the person in the water to the rope ladder, as to enable the persons who lower the ladder, to let it down till the cross-bar *k* reaches the water; *l* is a hook to hang the floating light upon.

Fig. 8, *m* is the reel for the line, by which the floating light is to be lowered.

Although the floating light above described, is perfectly adequate to the end designed, and the invention of it is highly creditable to its benevolent proposer, yet it is much to be apprehended, that the use of it will not be rapidly extended. Men are strongly disposed to forbear precautions, from the neglect of which they expect they shall not suffer. The most effective step towards rendering the use of it general, would be its introduction on board national vessels, for which useful expense is seldom spared; the value of the invention would then appear, as a record could be obtained of the number of cases in which it proved conducive to the saving of lives; and the loss of a man whom the use of it would have saved, might become a disgrace to the owners and captain of any vessel unprovided with it.

A portable Machine for loading and unloading Goods.

A portable machine for loading and unloading goods is calculated to render essential service to tradesmen who wish to manage their concerns with as much compactness as possible. The one now announced is capable of lifting a ton weight while worked by one man only, and even when so constructed as not to exceed one hundred and twelve pounds in weight.

It is represented at fig. 1, plate XLIX. A the winch by which the bar B, having thereon two endless screws or worms, CC, which, working in the toothed wheels DD, fixed to the barrels EE, round which the ropes FF, coil, wind up or let down the load, as the occasion requires.

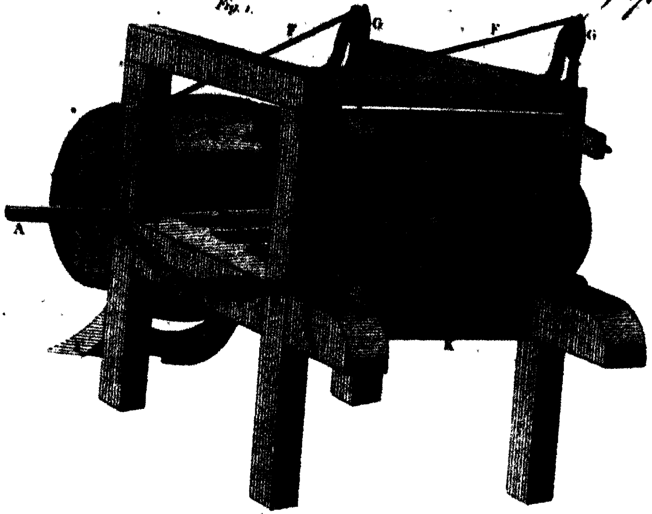
The ropes FF, passing over the two pulleys GG, are brought round; and their ends, having hooks for that purpose, are hitched into staples, fixed to the front of the cart or other carriage. Within these ropes the load H is placed on a common pulley I, which forms an inclined plane, up which, by the turning of the winch, as the ropes are wound upon the barrels, the load is raised into the carriage.

KK, the frame, intended to represent the part of the cart or other carriage on which the machine is occasionally to be placed.

The whole of the barrels and cog-wheels are contained in an iron box L, the sides of which are represented in the plate as taken off, that the construction of the several parts may be shown.

Davis's Machine for Loading and Unloading Goods.

Fig. 1.



Besant's Undershot Water Wheel.

Fig. 2.

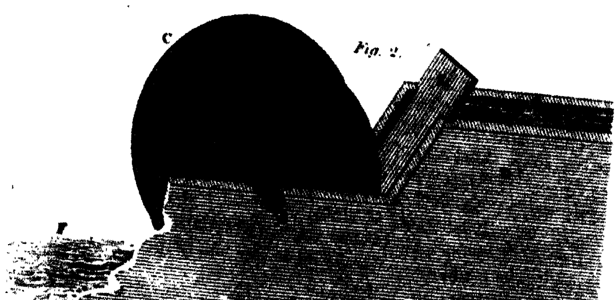
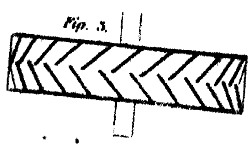


Fig. 3.



Published by Henry Fisher Caxton London 1824

Construction of a new undershot Water-wheel.

To point out the superiority of the new construction, the following considerations relative to the common undershot water-wheel must be premised:—

First,—In common water-wheels, more than half the water passes from the gate through the wheel, without giving it any assistance.

Secondly,—The floats coming out of the tail-water are resisted with almost the whole weight of the atmosphere, at the instant they leave the surface of the water.

Thirdly,—The same quantity of water which passes between the floats at the head, must of course pass between them at the tail, and consequently impede the motion of the wheel.

In the new water-wheel, described below,

First,—No water can pass but what acts, with all its force, on the extremity of the wheel.

Secondly,—The floats coming out of the water in an oblique direction, prevent the weight of the atmosphere from taking any effect.

Thirdly,—Although the new water-wheel is heavier than that on the old construction, yet it runs lighter on its axis, the water having a tendency to float it.

Fourthly,—By experiments made with models, it appears that the new wheel has many advantages over the common wheel; and as, when it works in deep tail-water, it will carry weights in the proportion of three to one, it will be particularly serviceable in tide-mills.

A, plate XLIX, fig. 2, the body of the water-wheel, which is hollow, in the form of a drum, and is so constructed as to be proof against the admission of water within it.

B, the axis on which it turns.

C, the float-boards, placed on the periphery of the wheel. Each board is obliquely fixed firm to the rim of it, and to the body of the drum.

D, the reservoir, containing the water.

E, the penstock, which regulates the quantity of water running to the wheel.

F, the current of water which has passed the wheel.

Fig. 3, Is a front view of the water-wheel, showing the oblique direction in which the float-boards C are placed on the face of the wheel.

A Mill for grinding hard Substances.

In plate L, fig. 1, where the representation of this mill is given, the front is supposed to be removed, to show the interior construction.

A, is the hopper or receptacle of the substances intended to be ground.

B, a spiral wire in the form of a reversed cone, to regulate the descent of the contents of the hopper.

C, an inclined iron plate, hung upon a pin on its higher end: it agitates the wire B; its lower end rests on the grooved axis D.

D, the grooved axis, or grinding cylinder, which acts against the channelled iron-plate E.

F, a screw on the side of the mill, by means of which the iron-plate E, is brought nearer to or removed further from the axis D, according as the substance to be ground is wanted in a coarser or finer powder.

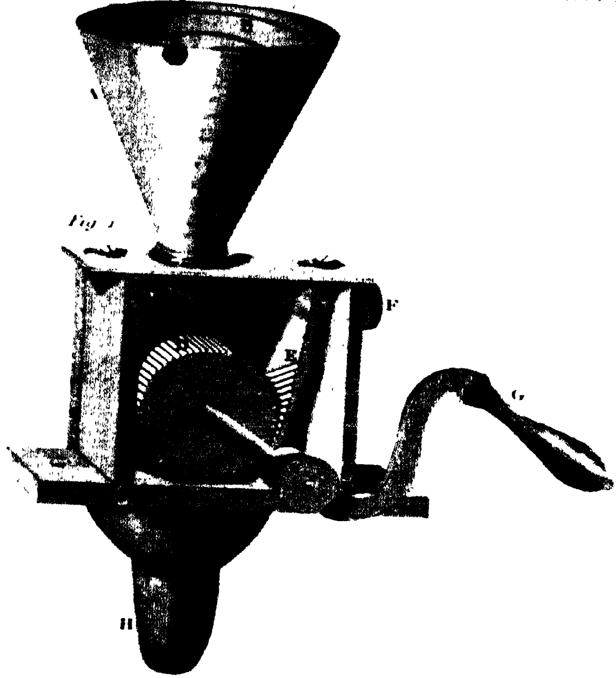
G, the handle by which motion is given to the axis.

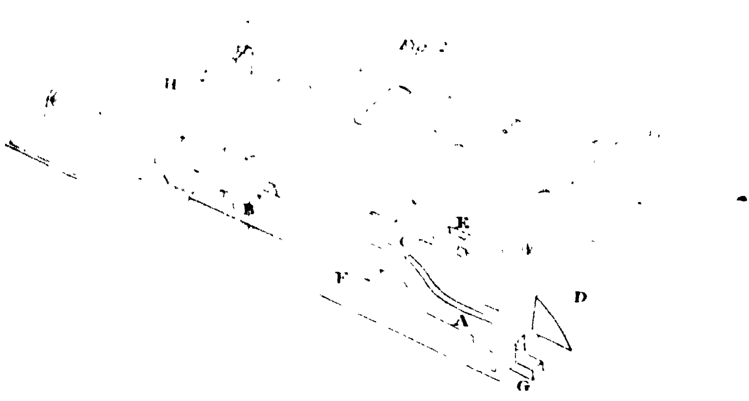
H, the tube from whence the articles, when ground, are received.

A mill of this description has been found perfectly well adapted to the purpose of grinding coffee, bones, ashes, and similar substances; it has also been found effectual and expeditious in breaking down beans, pease, malt, barley, &c. The spiral wire in the hopper, forms a very simple and useful addition to the mill, and saves the loss of time which frequently occurs by the stoppage or irregularity of the supply from the hopper, in mills which have no such convenience. This part of the invention may be applied with great facility, and at an inconsiderable expence, to mills at present in use of other constructions.

Although a mill of this construction is, as just stated, adapted to grind hard substances, of different degrees of hardness; yet when it is intended to grind only substances of one sort, or different substances of the same degree of hardness, it may be specially adapted to them. This will consist in forming the teeth of the grooved axis D by surfaces making an angle more less acute, according to the resistance to be overcome:—the more acute angle having the sharper edge, is of course fittest for the softest substance.

Mill for grinding hard Substances





Improved Drawback Lock for House Doors.

It is well known, that the bevel of the drawback house-door lock in common use is apt to become rusty; in which state it requires great force to shut the door, besides occasioning a disagreeable noise, and shaking the building. It has frequently happened, also, that the house has been exposed to robbery, from the door being left unlatched, when supposed to be fast. The improvement proposed removes all these inconveniences, as it lets the bolt shoot into the staple immediately when the door closes, but not before; and the reliever works so very easily, that the door is made fast with one twenty-fourth part of the force required with locks upon the common construction. Two ounces added to the reliever will shoot the lock with more ease than three pounds will do, applied to the bevel bolt; and if the lock is rusty, the advantage will be much more in favour of the new method. The construction of the improvement is simple and cheap; and it may be added to any old lock. It may be advantageously applied to French windows and glass-doors, as it prevents the doors from being strained, or the glass broken, by the force applied to shut them.

* A, fig. 2, plate L, is the new iron latch here affixed to an old common drawback house-lock.

B, an iron pin at one end of the latch, on which pin it is moveable.

C, a projecting part of the latch, which, when the common spring bolt D of the lock is drawn back, in the usual manner, is forced into the nick on its higher part at E, by the spring F, underneath the latch.

The bolt D then remains within the lock, until, on closing the door, the reliever G gently presses on the lock box, fixed in the common way on the door cheek; which pressure draws the projecting part C out of the nick E, and permits the end of the bolt D, by the force of the spring H, to slide into the lock box, and fasten the door.

Improved Jury Masts.

The improved jury masts are intended to be formed from the spare spars usually carried on board king's ships, and in every merchantman that is properly found. They will enable the ship to carry as much sail as on the usual regular mast; and the value of such an acquisition, in case of necessity, all nautical men are qualified to appreciate.

In plate LI, figs. 1, 2, and 3, AA represents the partners or pieces of timber which are bolted to the quarter deck for the mast to rest upon.

B is the stump of the lower mast, which is cut square at the top, and of the same size as the head of the original mast; upon this square, the main and spare lower caps *a a* are fixed; two mortises must be cut in the partners AA, to receive squares made at the lower ends of the two temporary masts DD, which are supported by the caps *a a*; one of them is a spare main top-mast, the other a hand-mast; these two support the main-top E, additional squares being made on the tressel-trees to receive each of them.

b Is a cap shown in fig. 2, made of four-inch plank doubled for the purpose, and fitted upon the heads of the masts DD, for a fore top-mast FF, the heel of which rests in a mortise made in the stump of the lower mast; it is also steadied by a double cap G, separately shown in fig. 3, on which it fits finally on the top.

The top-gallant mast H is fixed to the mast F by the top and cap in the usual manner.

The figs. 2 and 3 show the caps separated from the masts, and are the only things necessary to be made for the purpose; and the object of the cap, fig. 2, is to steady and prevent any wringing of the lower jury mast, and to fid the top-mast whenever it is reefed.

The fore top-mast FF appears in two separate pieces on account of its length.

Improved Construction of Anchors, and Mode of fishing them.

The great expense of timber for anchor-stocks, and the frequency of their failing or giving way in the centre, where the square of the anchor is let into the stock, induced the inventor to think of devising some plan of an anchor which might be cheaper in construction, and more likely to hold in various situations, than those in common use.

The new anchor, in external appearance, differs very little from the common anchor; the improvement consists in forming and fixing the shank of the anchor to the stock.

The stock *a a*, figs. 6 and 7, plate LI, is made of two pieces of oak bolted together, and well secured by hoops. In the common method, in order to prevent the anchor-stock from slipping off the shank, a square projection *b b*, fig. 8, is forged upon the shank; this is improved as shown in fig. 6, where this projection *d d* is extended on each side of the shank, far enough to receive two bolts through each of these extensions, which bolts hold firmly together the two pieces of timber which form the stock, and secure the stock fast to the shank. Two iron hoops, fig. 7, *e e*, are driven on the stock between the bolts, and *f f f f* are other hoops, and *g g g g* are treenails to strengthen the whole. On account of the additional weight of the stock, there is a greater probability that this anchor will hold in the ground; particularly in the case of banks which shelve suddenly down from the shore, as at St. Helena, Cawsand Bay, and indeed most of the islands of the West Indies. The proportion of additional iron is in all anchors to be twice and a half the diameter of the shank from each side at the stock; and of course this mode will supply the place of the present nuts, which are only intended to prevent the stock from slipping in and out whenever it becomes loose, an accident to which anchors are very liable in hot climates.

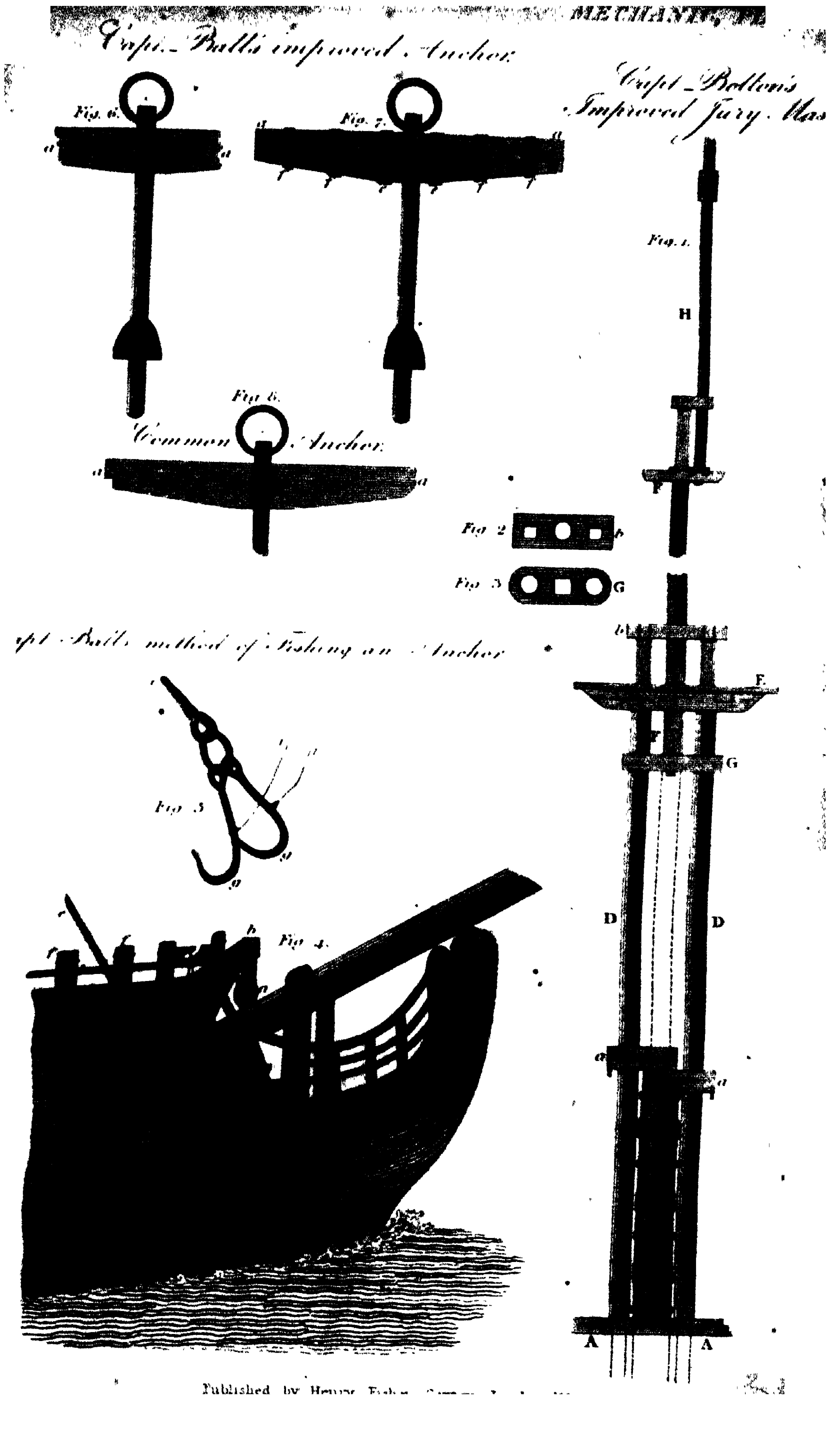
The common mode of fishing an anchor is frequently attended with accidents both to the ship and crew, from the anchor slipping unexpectedly in raising it to its proper position. A hint therefore for rendering it more safe and easy cannot be unacceptable.

Fig. 4, plate LI, represents the new mode of fishing an anchor, fig. 5, is an enlarged view of the double hooks for this purpose.

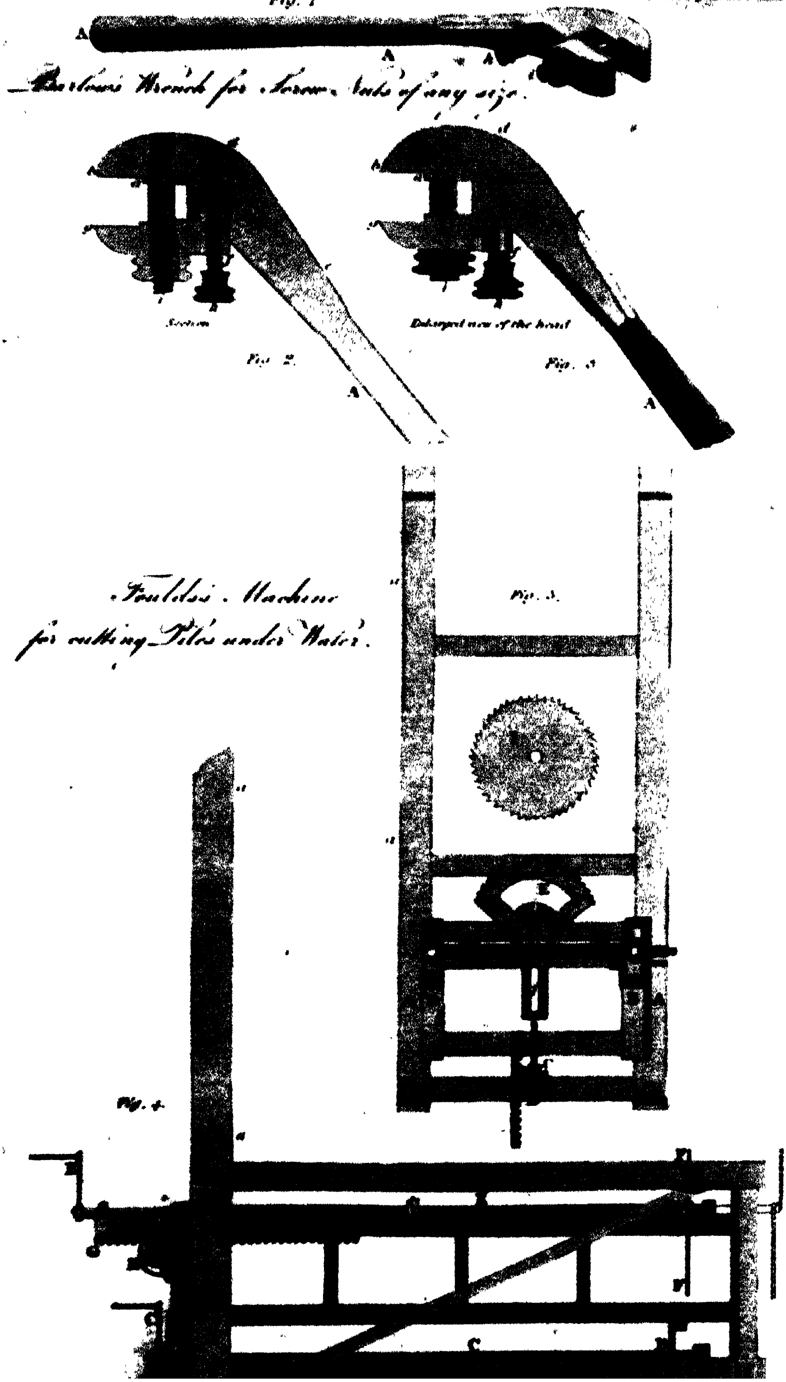
In the usual operation of heaving an anchor, it is drawn up by the cable until it appears above water; the cable will not now raise it higher; it is therefore bowsed up by the cat-block *a*, fig. 4, from the cat-head *b*, the cable *d* being slackened out as it rises. When it is got up as high as the cat-block will raise it, a strong hook, called the fish hook, fastened to a rope *e*, which is suspended by a tackle from the shrouds, is hooked to the anchor at the bottom of the shank, and thus the arms of the anchor are elevated above the stock, until one of the flukes is brought up to the timber heads *f f*, to which it is made fast by a rope and chain, called the shank painter. In this operation the fish-hook sometimes slips and occasions mischief, to remedy which, it is proposed simply to apply two hooks instead of one, by which a firm hold will be obtained. These hooks are shewn upon an enlarged scale at *g g*, fig. 5, attached to the rope *e*; each of these hooks takes one of the arms of the anchor, close to the shank, and holds it firmly. *i i* are two small lines made fast to the hooks, to direct them so as to get proper hold of the anchor.

Universal Screw Wrench.

The utility of a screw wrench which can be adapted to screw heads and nuts of different sizes, is well known to persons who have the care of machinery. For want of such a one, or for want of one which can be used with the same steadiness and effect as a solid wrench, screw heads and nuts are often considerably injured. The new wrench, by means of a nut and screw, is adjusted with the greatest ease to the exact size required, and in that state may be rendered more steady than any one hitherto invented. It is represented in plate [illegible]; fig. 1 is a perspective view of it; fig. 2 is a section of its head; and fig. 3 an enlarged representation of the head. The screw head or nut to be turned is held between two jaws, one of which *a b d e*, is forged in the same piece with the handle AA; the other, *f g*, is moveable between two cheeks, and fastened to the fixed jaw by the strong screw *i*, which is [illegible] jaw, passes through the moveable one, as [illegible] fig. 2, and has a nut screwed upon it; the [illegible]



Published by Henry Fisher


Fig. 1
Barlow's Wrench for Screw Nuts of any size.
Section
Fig. 2
Enlarged view of the head
Fig. 3
Foulds's Machine for cutting Piles under Water.
Fig. 3.
Fig. 4.

through the moveable jaw, and its point presses upon the bottom of a cavity made in the fixed jaw, shown at *m* in the section fig. 2. To make the wrench fit any particular screw head or nut, the nut upon the strong screw *i* must first be loosened, and the screw *h* screwed in or out of the moveable jaw, until the opening *b g* is just the proper width to receive the screw head or nut to be turned by the wrench; the nut of the screw *i* is then to be screwed down, until it presses upon the jaw and holds it perfectly tight.

Machine for cutting off Piles under Water.

In plate LII. figs. 4 and 5, AA is the external frame, which is framed at right angles; and when the frame *a a* is laid level, the piles are cut off perfectly so or in any other direction in which it is placed.

BB, internal frame.

CC, upright spindle and handle, which, with the racks and pinions,

DD, advance or recede the internal frame.

EE, upright spindle and handle fixed to the internal frame, by which the saw FF, is worked. In a piece of iron, fixed behind the saw, is a mortise *f*, by which the saw is admitted to advance upon its centre as the work goes on; and thus the piles may be cut in any direction required. The saw is held fast or loosened by a screw underneath.

GG, vertical racks, worked by a horizontal spindle with pinions, by which the internal frame and saw is raised and lowered, to cut off piles at various heights.

HH, a wheel with pall, to support the frame at any determined height.

I, a circular saw to be used occasionally.

Machines for Shoemakers.

The posture in which shoemakers work when sitting, is exceedingly injurious to their health; occasioning piles, gravel, indigestion, and other severe disorders, which often ultimately bring them to a premature grave. The invention of the first machine made to enable shoemakers to work in a better position, originated in a hint given to Thomas Holden of Fettleworth, one of the trade, by Peter Martin, of Felborough, surgeon, who recommended his patient to relinquish his business, or invent some method to do his work standing. The machine produced, resembled in its general form a small stand or three-foot table, the top of which was little more than the size of a shoe, and was moveable, so as to be easily set at any inclination. Afterwards other machines for the like purpose were invented by different persons; particularly one in 1804, by a Thomas Parker of London, who stated to a Committee of the Society for the Encouragement of Arts, &c. that he had never heard of any invention for the same purpose. He was rewarded with fifteen guineas. His machine consists of a bench standing on four legs, the top of it being about four feet from the ground. A circular cushion, in diameter at least equal to the length of a shoe, is placed on the bench. Through the centre of the cushion, and through the bench, is a hole to admit a strap, which being brought double through the hole, forms on the top of the cushion a loop to admit the shoe, containing the last. When therefore the lower ends of the strap are fastened to a board on the floor, like the treadle of a foot-lathe, the workman, pressing upon this board, holds the shoe sufficiently tight upon the cushion to proceed with his work, and by taking off the pressure of his foot, the shoo can be turned or taken of. The cushion is a block of wood, and is directed to be stuffed with wool or hair to give it elasticity, and covered with leather. A small cushion is used to adjust the position of the shoe occasionally. The cost of this machine is estimated at two guineas.

Subsequently other machines have been invented with the same view as the above, and we shall describe three of them, which appear to combine the most important requisites.

FIRST MACHINE.

This machine is entitled a " machine for boot and shoemakers," but is principally designed for the latter. It has been much approved by the trade, as affording great comfort and convenience. It is represented in plate LIII.

Fig. 1, *a*, the bench, standing on four legs, about four feet from the ground.

b, a circular cushion affixed to the bench, in the centre of which cushion is a hole quite through the bench, through which a leathern strap *c* is brought up from below. This strap holds the work and last firmly upon the cushion, in any position required by means of the workman's foot placed upon the treadle *d*.

e, Shows the last upon the cushion, with the strap holding it firm.

f, Is a seat for the workman to use occasionally: it is supported behind by two legs, and in the front by a cross piece of wood, into which a projecting arm extends from the seat, and allows the seat to be removed nearer to or further from the work, as may be required.

g, A shelf on which the hammer may be laid.

h, A leathern bag, to contain the tools.

i, A drawer to hold such articles as should be kept free from dust.

k, Leathern slips to contain the knives.

l, A whetstone, on which the knives are to be sharpened; it is moveable on an upright pivot or axis *m*.

n, The upper part of the bench, to hold the lap-stone, &c.

Fig. 2, the lap-stone. The conical part *o*, fits into the hole in the cushion *b*, so as to be firm whilst the leather is beaten with the hammer.

SECOND MACHINE.

This machine will answer the purpose of the shoemaker, but is more particularly intended for the use of boot-closers, harness-makers, leather-pipe makers, &c. to enable them to perform their work in a standing posture, and it has been found upon trial to answer the ends designed.

Fig. 3, plate LIII, *a* the clamp or boot-holder, having a cross joint acting within the block *b*, more plainly shown in the section of the block at fig. 5.

c, A strong piece of wood firmly fixed in the table, having three holes or mortises to receive the tenon of the block *b*, and thereby alter the position of the clamp or boot-holder; the sloping one is for saddlers' work; the other two being one over the other, are to raise or lower the work, to suit the height of the workman. *d d*, The lower arms of the boot-holder; *e e*, straps from the pedal *m*, joined to the arms by small hooks, by which means the foot being pressed on the pedal, tightens the work in the boot-holder; *f f*, a box or table with a drawer under it.

g, A crossing strap, serving for the pedal strap to be fastened to when the boot-holder is placed obliquely.

Fig. 4, a side view of the block, and of the boot-holder clasping a piece of leather.

Fig. 5, a section of the joint in the block, one arm of the clamp or boot-closer being mortised through the other.

Fig. 6, a side view of a table with a half round arm *h* (mortised into the post *i*) having a strap *k* reaching down to the pedal to hold the work on; *l*, another mortise for the post *i*, to turn the other end foremost.

Fig. 7, transverse section of the block *b*, figs. 3 and 4.

Fig. 8, a section of the block *h*.

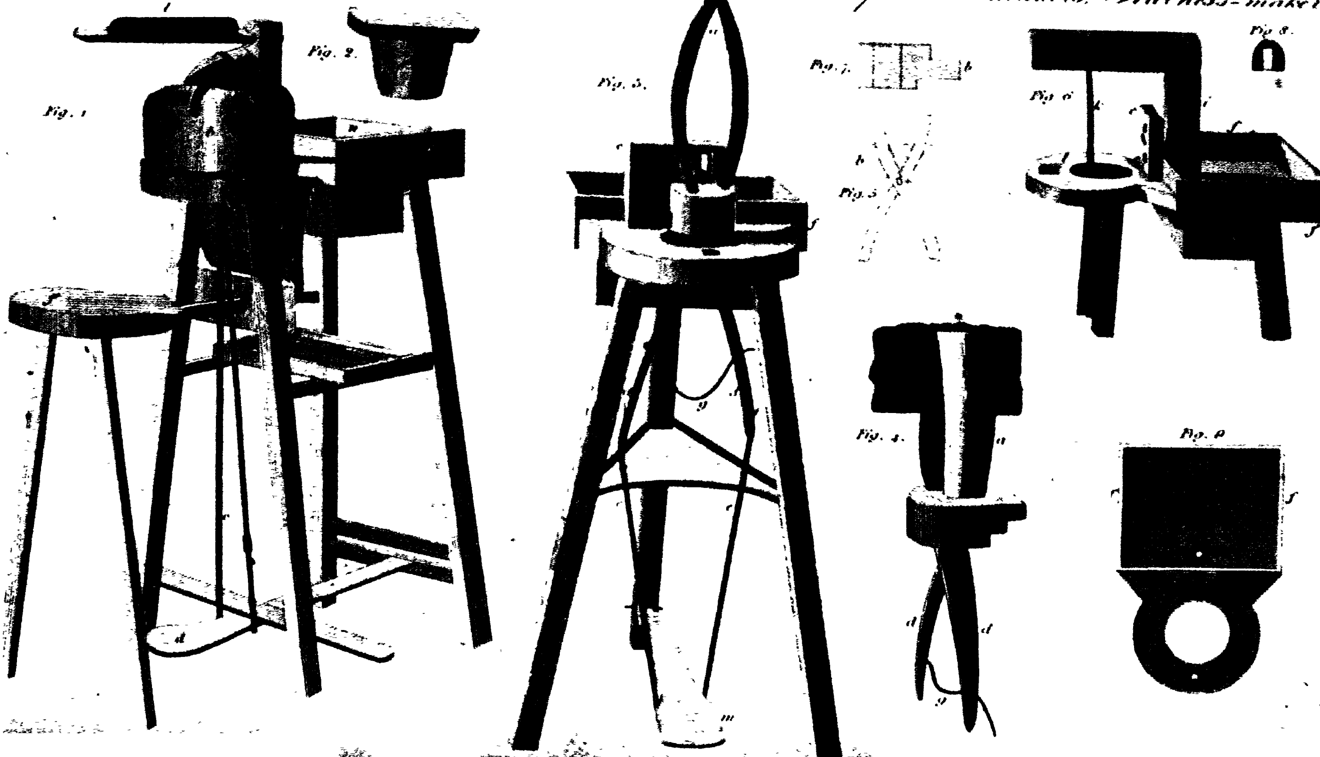
Fig. 9, a plan of the table, showing the two mortises of the post *i*.

THIRD MACHINE.

The last machine we shall describe for the use of this trade, is still more simple and economical than the preceding, and therefore extremely likely to be generally used. It holds the boot or shoe very steadily, and can be afforded at the price of seven shillings. It can easily be fixed to a window by screws, or by two or three holdfasts, with a strong foot to support the end to which the foot-strap is fixed; but many windows are so convenient as not to require a foot post. A shelf or board fixed near it will hold all the tools. The machine may, if required, be fixed on a small but very strong bench made for the purpose. The lever or stay which lifts up and down, and moves from side to side, is of great use. It will fit either a large or small shoe; when it is down, the shoe is held firm between it and the side of the machine, and kept tight by the foot pressing on the strap. When this lever is thrown back, it leaves room for the heel to go down and rest on the bent stay at the bottom,

Stass' Machine for Shoe-makers

Stass' Machine for Boot-makers, Harness-makers, &c.



so that the work at the toe may be done with pleasure; and when any thing is wanting to be worked at the heel, the toe rests on the stay below, and is in most cases held by the strap.

Fig. 1, plate LIV, represents a plan of this machine; fig. 2, a perspective view of it in use; and fig. 3, a section through the middle. The machine consists of an oblong frame of wood formed of two sides AB fig. 1, with cross-pieces CDEF; it is very conveniently fixed in a situation, and at a proper height for working, by screwing it down to a window sill, (a position of which is shown in fig. 2, at G,) by means of two screws *a a*, such as are used for bedsteads; these, and an iron bracket I, fig. 2, extending from the front E, of the machine, being screwed against the wainscot P, support the machine very steadily; or a stand consisting of proper legs may be used if preferred. The parts ABDEF, of the machine, are covered with leather, so as to become like cushions to support the last, as shewn at L, fig. 2, and it is held down by a strap M, (in the manner shown by the figure,) which has a loop or treadle at the bottom for the foot. The principal novelty of the invention, consists in a lever H, which is attached by an iron link *b*, to a wire *d*, fig. 1, upon which it moves as a centre; and when that is down in its place, as in fig. 1, a small point or beak of iron *d*, fig. 3, enters into holes made in an iron plate *e*, and the other end of the lever comes to rest on a top *f*, which, as shown in fig. 1, has several holes in it; and the end of H has also a little iron beak which enters these holes; thus when the piece H is shut down, it becomes an immoveable cross-bar of the frame, and the last may be held or wedged in, between this and either side A or B of the frame, in the manner shown by the dotted lines in fig. 1, and may be held down by the strap M; but to adjust the width of the opening HA, or HB, (fig. 1,) on which the last lies, nothing more is necessary than to lift up the lever H, so that the point *d*, fig. 3, clears the holes of the plate *e*, then sliding the link *b*, along the wire *d*, to the intended width, and shutting it down again, the beak or the point *d*, fig. 3, enters some other hole in the plate *e*, and holds the lever H fast in the new position, so as to adapt it to the width of any last, or to hold it in any position at pleasure.

At other times the last is held down in the manner of fig. 2, by the foot-strap M, pressing the lever H upon it; in

fact the machine forms an universal vice, which will support and hold the last firmly down upon the cross-bar F, in any required position; g and h, fig. 1, are very stiff pieces of sole leather fixed in the frame, which, in certain positions, also support the last.

Method of constructing an air-tight Door-hinge.

This invention was applied in the first instance to the joints of a folding screen, so as to fold either way without admitting the smallest quantity of air, but it is equally applicable to the hanging of doors.

Fig. 4, plate LIV, represents a plan of the joint AB two sides of the screens with circular ends, joined by a piece of leather reaching from top to bottom, fastened at C, and wrapping (like the letter s) partly round the curve of one fold of the screen, and partly round the other to D, where it is also fastened.

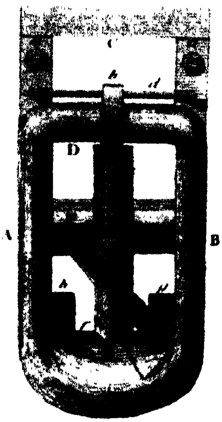
EF, a chain formed of brass plates riveted together, winding round in a groove from off one fold of the screen on to the other, the contrary way to the leather, and thus mutually keeping each other stretched tight, the chain winding on when the leather winds off, and *vice versa*; thus they move smoothly round one another.

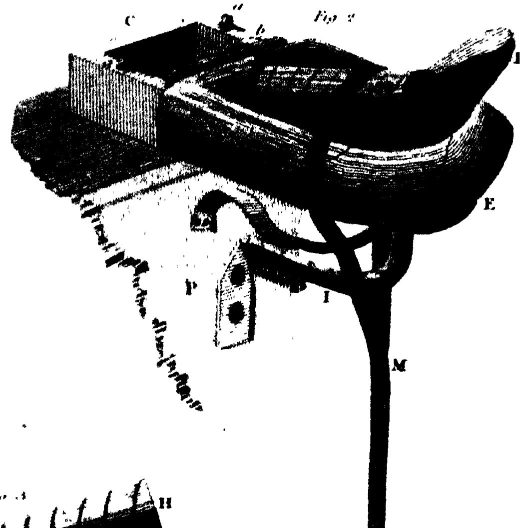
G, fig. 5, a piece of brass (left out in the last figure, in order to show the chain) screwed to the centre of each curve of the screens which forms the hinge; and by keeping the folds of the screens at their proper distance, secures the easy action of the chains and leather, and prevents their being over-stretched.

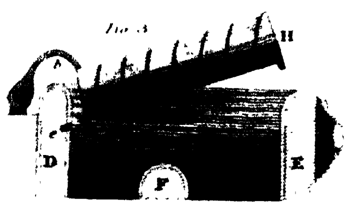
HH, a line of green twist fastened along the bottom of the screens, and fastened through a staple on the joint at G, serving to keep the screen air-tight on the floor.

Fig. 6, is an elevation, showing the top and bottom joints, with the same letters of reference.

King's Machine for Boot and Shoe Makers.

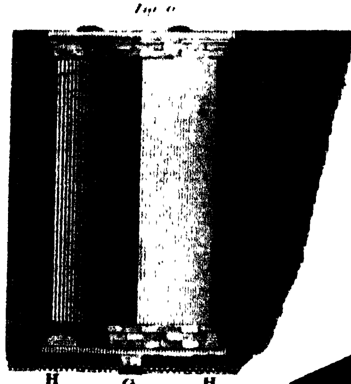


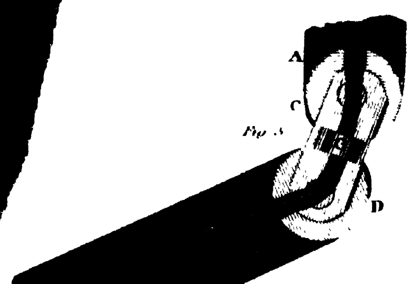






[illegible] Air-tight Door Hinge.





Construction of Time-keepers delivered to the Board of Longitude, March 7, 1805.

The escapement is detached, and the best of all others for an equal measure of time: because the vibrations of the balance are free from the friction of the wheels, in the manner here adopted, except about one-twelfth part of the circle, whilst the scape-wheel acts on the pallet to keep up the motion of the balance, which is done with considerably more power and less friction than by other escapements, because it receives but one blow from the wheel, whilst other escapements receive two; it has also an equal advantage in the quickness of train, and when the impulse is given to the balance by the wheel, it is given in a similar direction, and not in opposition, as most escapements are which produce recoil. This is clearly proved by its causing a heavier balance to vibrate to a greater distance. The escapement should be made in the following manner.

The pivots of the balance axis should be the size of the verge-pivots of a good common-sized pocket-watch, and of the shape shown at fig. 1, plate LV, which will greatly add to their strength, the extreme end, or acting part, only being straight; the jewel-hole should be as shallow as possible, so as not to endanger cutting the pivot, and the part of action of the hole made quite back, with only a very narrow chamfer behind to retain the oil; deep holes are very bad, for when the oil becomes glutinous, it will make the pivots stick, so as to prevent the balance from its usual vibration. The pallet should be half the diameter of the wheel, or a little larger, for if smaller, or one-fourth of the diameter, as Arnold's is, the wheel will then have too much action on it, which will increase the friction considerably, and likewise cause the balance to swing much farther to clear the wheel; consequently a check in the motion of the balance may stop the watch; and this, doubtless, often causes Timekeepers, so constructed, to stop. The face of the pallet should run in a line of equal distance between the centre of the pallet and its extremity, and not in a right line to its centre, as this causes an increase of friction, and a loss of that power which is obtained by the wheel acting on the extremity of the pallet: This is clearly proved by time, from the holes worn by the

points of teeth in all pallets that run in a line to the centre. The scape-wheel teeth should form the same direction as the face of the pallet, under cut for the said purpose of avoiding friction, and maintaining the power, and for safe locking. The points of the wheel teeth must not be rounded off, but left as sharp as possible. The pivots of the scape-wheel are to be a very little larger than the balance-pivots.

The wheel is locked by a spring instead of a detent with pivots, as the French have made them; for those pivots must have oil, and when the oil thickens, then the spring of the pivot detents is so affected by it as to prevent the detent from falling into the wheel quick enough; the consequence of this is, irregular time and stoppage of the watch; and if ever such a watch went well for twelve months, accident must have favoured it.

When the spring is planted on the side of the wheel, as in this escapement, the part on which the wheel rests should be a little short of a right angle, so that the wheel may have a tendency to draw the spring into it; for if sloped the other way, or beyond a right angle, it will have a tendency to push the spring out; in that case the wheel will have liberty to run. The wheel should take no more hold on the spring than just sufficient to stop it; for if more, friction will be increased. The small return spring should be as thin as possible at the end fastened to the other spring, but at the outer end a little thicker; the spring should be planted down so close to the wheel as only to be just free of it. The discharging pallet about one-third, or nearly one-half the size of the large or main pallet, the face of it in a right line to the centre, the back of it a little rounding and off from the centre. Great care must be used in taking off the edges of this discharging piece, to make it round, to prevent cutting the spring, nor can it be made too thin if it will not cut; the end of it nearest the balance should be a little more out from the centre of the balance axis than the lower part of it towards the potence, for counteracting the natural tendency of the spring downwards from the pressure of the scape-wheel; and that part of the spring on which the wheel rests, should be sloped a little down, to give the wheel a tendency to force it up, to counteract the natural inclination the wheel has to draw it down by its pressure on it.

The balance is to be made of the best steel, and turned from its own centre to its proper size, then put into a crucible with as much of the best brass as, when melted, will cover

it. The brass melted will adhere to the steel; (if any other metal is used by way of solder, the watch cannot go well;) then turn it to its proper thickness, and hollow it out so as to leave the steel rim about the thickness of a repeating spring to a small-sized repeating watch, turn the brass to twice or near three times that thickness of steel, cross it out with only one arm straight across the centre, and at each end of the arm fix two screws opposite to each other through the rim of the balance, to regulate the watch to time; the diameter of the heads of these screws about equal to the thickness of the balance, a little more or less is not material. The compensation weights should be made of the best brass, and well hammered, and a groove turned to let the rim of the balance into it, and this should be cut into fourteen equal parts by a wheel engine: then you will have seven pair of pieces of equal size and weight; two of these pieces being screwed on the rim of the balance at equal distances, will produce an equilibrium, a balance in the full sense of the word, equal in all its parts. In making balances, great care should be taken that they get no bruises or bendings, for if they get a bruise on one side so as to indent the metal, that part will be less affected by heat and cold than the other parts which have not received the same violence to close their pores; consequently the balances made by rule of thumb, bending, hammering, and filing, without one single truth about them, must to the poorest mechanic be inconsistent in the extreme, as no worse method can be taken, and the piece can only go well by some error compensating for others; for should there be one stroke of the hammer on the compensation piece on one side of the balance, more than on that on the other, heat and cold will produce different effects on them; and if the two metals which compose the compensation for heat and cold be soldered together, it is still worse, as then the compensation will be composed of three metals instead of two, three acting bodies, as follows:—The brass has a tendency with every change in the atmosphere to move one way; the steel has a tendency to move the same way, but not so rapidly as the brass: but the force of the brass warps the steel with it; here then they might act pleasantly together; but the middle, or soldering metal, between the brass and steel, having a greater tendency to rapid motion than the other two, and being confined between them, will undo that natural easy accordance which they without it would have possessed, and will act as a third man between two men of equal force, but not so rapid in action as the middle one,

warping with him either way his inclination is to move: and the said natural easy accordance in two metals, so necessary to obtain perfection, must not be destroyed by a third.

Balances are likewise spoiled by bending the compensation pieces; bending cracks and destroys the compact body of the metal. The soldering up these cracks with a metal very different in expansion to the metal cracked is hurtful, nor is it possible to bend the compensation pieces into a true circle; in that case, they form so many parts of different circles, that nothing regular can be produced; nor a more inconsistent method of making expansion-balances be imagined. The mode of making them, as well as the workmanship, are generally wretched in the extreme.

To adjust the balance in heat and cold:—Put the watch into about 85 or 90 degrees of heat by the common thermometer; mark down exactly how much it gains or loses in twelve hours, then put it into as severe a cold as you can get for twelve hours, and if it gains one minute more in twelve hours in cold than in heat, move the compensation weights farther from the arm of the balance about one-eighth of an inch; and if it gains one minute more in twelve hours in heat than in cold, move the weights one-eighth of an inch nearer to the arm of balance; and so on in the like proportion, trying again and again, till the watch goes the same in whatever change of heat or cold it is put in.

Much difficulty has fallen to the lot of watchmakers, in the endeavour to make timekeepers go nearly the same in all positions; the Inventor has had his share of this, but it is now over; by far the greatest part of this difficulty arises from the balance-spring not being properly made. But if the spring is made, as shall be described hereafter, you have only to make the balance of equal weight, and it will go within a few seconds per day, in all positions alike; and if it vibrates not more than one circle and a quarter, a small matter of weight applied to that part of the balance which is downward when in the position that it loses most, will correct it with great accuracy; but if it vibrates more than one circle and a quarter, then it will require the weight to be above instead of below; and after the watch has been going a few months, and its vibration shortens to one circle and a quarter, then it will go worse and worse by reason of the weight being in the wrong place; to avoid this evil, it is absolutely necessary to confine the vibrations to one circle and a quarter, which will produce the most steady performance. It is com-

Earnshaw's timekeeper for discovering the longitude.

mon for watchmakers to admire a timekeeper when they see it vibrate a circle and a half, or more, and form an opinion of its excellence from this only; but the Inventor is aware from experience what would be the consequence, and has been condemned, because, when he has seen such watches, he saw enough to declare that they would not give very accurate performance.

Balance-spring.—To find out the invisible properties of this apparently simple part of the machine, has given much more trouble than all the rest. The Inventor despaired of bringing timekeepers to the state he has done, and unless those hidden properties are known to timekeeper-makers, however well they may execute all other parts, they will find their most sanguine expectations frustrated. He has seen watchmakers boast of their timekeepers going well for a month or two; and, from the knowledge he had of the effects produced by the balance-spring, he has told them that a month or two more would destroy their hopes. To explain this: the cylindrical spring being in all its turns of equal distance from the centre, in course every turn will be of equal strength, and called isochronal, and it has been believed that all vibrations, whether long or short, would be performed in the same time; but this is not true, for if a man is to go four miles in the same time that he has gone one mile, he cannot do it with the same power: no, he must have impelling force to quicken his motion, or he will be four times as long in doing it. Therefore, instead of the spring being equal in all its parts, it must be made to increase in thickness to the outer end, in such proportion as will cause the balance, when thrown to a greater distance, to return so much the quicker to make them equal; by long perseverance he found how to make such springs, and then he thought he had got all he wished for. But cruel disappointment nearly broke his heart, for he found he had yet another difficulty to break down, as his watches with such perfect springs were continually losing on their rates. What farther to do, he was long at a loss to determine; but, obstinate in the cause, and resolving not to give it up but with life, perseverance came once more to his aid, and with still more unremitting study, he at length applied the following remedy. He found in the course of reasoning on bodies, that watch-springs relax and tire like the human frame, when kept constantly in motion, and this may be proved by the following experiment: let a watch, that has been going a few months,

go down: let it be down for a week or two, or more, then set it going, and if it be a good timekeeper, so as not to be affected by the weather, it will go some seconds per day faster than it did when it was let down; but it will again lose its quickness in a gradual manner, gaining less and less till it comes to its former rate. Therefore finding that isochronal springs would not do—and likewise having made springs of such shape as would render long and short vibrations equal in time—constantly lose the longer the watch went; he then made them of such a shape as to gain in the short vibrations about five or six seconds per day more than the long ones; this quantity could only be found by long experience, and the way he proved this was to try the rate of the watch with the balance vibrating about one-third of a circle, then tried its rate vibrating one circle and a quarter, and if the short vibrations go slower than the long ones, that watch will lose on its rate: and if they are equal, it will likewise lose, but that only from relaxation; and if it gains in the short vibrations more than five or six seconds in twenty-four hours, it will ultimately gain on its rate; but if not more than that quantity, and the timekeeper is perfect in heat and cold, and every other part, the above properties will render it deserving of the name of a perfect timekeeper: and this is the principal cause of his timekeepers excelling others, and also of some of his timekeepers going better than others, though made by himself, the springs of them being made to accord more exactly with the above proportions: and this is the cause which has enabled him to foretell what his timekeepers would do, which Dr. Maskelyne, Crosley, and others, could testify. The above effect is produced as follows: he finds the common relaxation of balance-springs to be about five or six seconds per day on their rates in the course of a year; therefore the short vibrations are made, by the shape of the spring, to go about that quantity faster than the long ones, and as the spring relaxes in going by time, so the watch accumulates in dirt and thickening of the oil, which shortens the vibrations, the short ones then being quicker compensated for the evil of relaxation of the balance-spring. From this it is plain, that the causes of error in timekeepers are not undefined and vague in their nature, which has been supposed; for when it is certain that all causes of error may be over compensated, we cannot despair of finding out the medium, which may be easily proved by examining the going of the Inventor's

timekeepers. It will then appear, that what errors they are subject to, arise from causes certain and natural, and of course they may be corrected by art.

The detached escapement is a dead scape, if properly unlocked as here done, on the outside of the wheel. The unlocking on the inside is improper, being against the whole train of wheels, and causes a recoil. When the wheel is locked on the heel of the tooth instead of the extremity, the absurdity is too plain to the meanest mechanic, to need any comment; the notches cut by the pallet rubbing on the round face of the scape-wheel teeth clearly prove how much friction presides there; and such a wheel is much more difficult to make than the one proposed. The size of pallet selected, also tends most effectually to prevent watches from stopping.

With respect to the preference to be given to box above pocket-timekeepers, the former appear the best, for the following reasons: every watchmaker surely knows the influence of oil; if, by its change, it robs of its power a main-spring of the force of one pound, then a main-spring of one ounce must be sixteen times more affected by it; this is well known from the effect produced by the change of oil on pivot-detents, when timekeepers are made of a large size, merely for the purpose of having a large and powerful main-spring, to drag the works on through all impediments of oil and dirt; but before this is done, it should be considered whether an evil is not likely to happen, namely, the evil of friction, far greater than that of oil. There is a happy medium between these two evils. Whether the Inventor has found out that happy medium or not, he leaves to the judgment of every impartial man who may examine his timekeepers, in which he will not find cuttings and tearings in any part, or hardly be able to discover in the oldest of them the least trace or place marked on which the escapement has acted. Thus then, he thinks time and ocular demonstration will fix the wreath with him. It may be said, that in avoiding this evil, friction, he is subject to the mischief from oil; he trusts that the regularity in going, of his timekeepers, overturns that argument. There are only certain degrees of force which metals and all other bodies can bear, without tearing each other. As far as the bodies will resist this, go, but no farther; for when so much force is used as to cause the acting bodies to injure the surfaces of each other, or any one singly, the worst of all evils in timekeepers begins to be generated. His box-timekeepers have nothing

like the force of main-springs of some watches, yet they vibrate quite as far with a balance equally heavy; it is clear therefore, that their force, though so much less, produces all the advantages by avoiding friction, without being influenced by the oil, as their steady going fully proves. A pocket-timekeeper may go as well as a box one, but not generally so; and their going well principally depends on the goodness of the oil. Oil sometimes turns out so, as to shorten the vibrations of a pocket-timekeeper half its usual quantity; and in a few months would nearly, if not quite, stop it. The effect on a box one would be trifling.

On account of the difficulty of making watches go the same in different positions, gimbals have been introduced; and when properly made, they will have the desired effect.

The Inventor has compared his escapement with Arnold's in the following manner:

1st. This escapement has more vibration from the same power than his.

2nd. This is in consequence of the balance being more detached than Arnold's, which is of great advantage, having thereby less friction in the action of scape.

3d. Increase of friction destroys equality of motion, so necessary to determine the longitude; and has the same vibration can be obtained in this as in Arnold's with less power, consequently there cannot be so much friction in it as in his.

4th. Arnold's scape with pallet one-quarter diameter of wheel, requires one-third of circle to clear it; this scape with pallet one-half diameter of wheel, requires only one-sixth of circle to clear it, which is only half the quantity of action Arnold's has; consequently, friction is by that means most considerably reduced, and the causes that would stop Arnold's watch would not affect this, which is doubly detached to his.

5th. The causes which prevent these timekeepers from being so subject to stop as Arnold's, are, the difference in the shape of the pallet and the scape-wheel teeth, and principally in the difference of their sizes; these differences in their sizes and shapes have done away that which the watchmakers had not before the least idea of.

6th. The scape-wheel is locked on its extreme point, and unlocks in an easy manner, in a similar circle with the wheel. Arnold's is locked on the heel of the tooth, and nearer the centre, and unlocks in opposition to the whole train of wheels; which are two great disadvantages.

Earnshaw's timekeeper for discovering the longitude.

There are persons who have still the weakness to assert to this very hour, that the detents with pivots are better than the Inventor's spring; to which he answers in the following manner: Those pivots have friction in their action, the spring has none; the action in pivot-detents requires oil, that oil when it thickens and becomes glutinous, robs the tender spring of the pivot-detents of its power; the wheel then is subject to pass two teeth, and impedes the motion of the balance, which frequently stops the watch. The Trade could not follow the plans of Harrison and Mudge, because of their complexity; but they have with tolerable success, followed the Inventor's, from its simplicity, which accords with the following demands of the act of parliament: "provided that such method is generally practicable and useful."

Therefore, however well their watches may go, it is doing honour to, and proving the excellence and practicability of his inventions.

The best train for timekeepers is . . . . . 18,000.
Scape-wheel of pocket one . . . . 15 teeth.
Box one . . . . 13 „

Every thing else in the Inventor's timekeepers is well known to watchmakers. He has made and sent about one thousand of them into the world; many of them have been constantly employed in conducting the most valuable part of the commerce of this country in safety, and preserving his majesty's ships and subjects from rocks, sands, and lee-shores: and thus by the perseverance of his life to preserve others, he has greatly injured his health. And if, instead of this, he had turned his attention to the line of fashion and fancy in his profession, he would have avoided that evil, and been able long since to have retired with a handsome fortune.

DESCRIPTION OF THE TIMEKEEPER.

Fig. 2, plate LV, represents the timekeeper as together.

Fig. 3, the pillar-plate, from which the calliper may be taken; *a*, the height of the pillars.

Fig. 4, the barrel and main-spring; *b*, side view of barrel.

Fig. 5, the fusee and great wheel, with rochat to keep it going whilst winding up; *c*, side view of fusee.

Fig. 6, second wheel and pinion; *d*, side view of second wheel.

Fig. 7, third wheel and pinion; *e*, side view of it.

Fig. 8, fourth wheel and pinion; *f*, side view of it.

Fig. 9, represents the upper plate, with the escapement on it, from which the calliper may be taken.

Fig. 10, side view of the scape-spring which locks the wheel.

Fig. 11, one of the brass weights to be fixed on the rim of the balance for the compensation for heat and cold: *g*, the groove cut in it to receive the rim of the balance. The rim of the balance is cut through in two places, in opposite directions, as shown in fig. 2; and two of these weights are to be placed on the balance-rim, at equal distances, as there represented, and fastened by a screw as at *h*. These weights are to be moved backwards or forwards on the rim of the balance, to make the watch go faster or slower in heat or in cold, as by trial may be found necessary, and which is explained in page 366.

Fig. 12, side view of the brass weight; *k*, the groove to receive the rim of the balance; its depth shows the breadth for the balance rim.

Fig. 13, the cylindrical balance-spring. The only advantage attending the cylindrical shape is, that it is rather easier made, a saving of about one hour of time; for if a spring be made as described in pages 367—8—9, it is of no consequence in what shape it is turned, whether cylindrical or spiral.

OF THE ESCAPEMENT.

The model from which the drawings in plate LVI, were taken, contains, besides the parts necessary to explain the nature of the escapement, a box, inclosing a spring, which, when wound up, communicates, by means of some more wheels, a force to the balance-wheel sufficient, when the balance is put in motion, to keep it in action for some time. These wheels are contained between two brass plates, fastened together by four upright pillars; the uppermost of these plates is that which is represented by fig. 1, where PQRS are the four screws that take into the heads of the four pillars abovementioned, and connect it to the remaining part of the model. The plate PQRS, contains, however, the whole of the parts

necessary for the present purpose. The side of this plate represented to view, is the undermost when fixed in the model: so that the figure represents this plate as taken off, with the side next to the balance laid upon a table, and the eye is supposed to be placed perpendicularly over it.

In the plate PQRS is an opening, or a piece taken out, represented by TUWXYZ. In this opening the balance-wheel ABCD, pallet MSK, and part of the balance UV, are seen. The balance-wheel is supported by two pieces of brass, ONH, OI; the piece ONH is screwed to the side of the plate nearest to view, by a strong screw *t*, and made firm by small pins, represented by *rrrrrr*. These pins are called steady pins; they are riveted fast into the supporting piece OH, and take into holes in the plate PQRS, made exactly to fit them. The part ON of this supporting piece, is supposed to be raised above the part *t* H by a joint or bend at N; the other supporting piece OI is fastened to the opposite side of the plate; and between these two pieces the balance-wheel turns freely and steadily in the direction of the letters ABCD. The small wheel MSK is called the large pallet; it is a cylindrical piece of steel, having a notch or piece cut out of it at *l h r;* against the side of this notch is a square flat piece of ruby, or any hard stone *h l*, ground and polished very smooth, and fixed fast into the pallet. The cylinder is so placed, with respect to the balance-wheel, that it may not be more than just clear of two adjoining teeth. EF is a long thin spring, which is made fast at one end, by being pinned into a stud G, and made to bear gently against the head of an adjusting screw *m;* the other end is bent a little into the form of a hook; to this spring there is fixed another very slender spring at *y*, which projects to a small distance beyond it. This small spring lies on the side of the thick spring nearest to the balance-wheel. The adjusting screw *m* takes into a small brass cock *a p*, which is screwed fast to the plate PQRS, by a strong screw at *p*. Upon the spring EF there is fixed a semi-cylindrical pin, which stands up perpendicularly upon it, and of a sufficient length to fall between the teeth of the balance-wheel ABCD. This pin is called the locking-pallet, and is placed on the opposite side of the spring represented to view. Through the centre of the cylindrical pallet MSK, a strong steel axis passes called the verge; the pallet is made fast to this axis, which also passes through the centre of the balance, and is made fast to it; it has two fine pivots at its extremities, upon which it turns very freely, between two firm supporting pieces

of brass, screwed firmly, and made as permanent as possible, by steady pins, to the principal plate PQRS; one of these pieces is represented in the figure by *w y* L: the part *w* is raised above the part *y* L by a bend or joint at *y*; the part *y* L being represented as fixed firm to the plate by the strong screw at *y*. This piece is called the potence, and is exactly similar to the other supporting piece, which is called the cock, that is similarly fixed to the opposite side of the plate, and hid from the sight in the figure. A little above the cylindrical pallet MSK, (as it appears in the figure,) is fixed a small cylindrical piece of steel *i n*, having a small part projecting out at *i*, through which the verge also passes; this is called the lifting pallet: it fixes on the verge like a collar, and is made fast by a twist, so as to be set in any position with respect to the large pallet MSK. The balance lying below the plate PQRS, only the part UV is represented to view: the continuation of the position of the circumference, however, is represented by the dotted lines ULHV. The end EG of the long spring EF being made very slender, if a small force be applied at the point *o* to press that end out from the wheel ABCD, it easily yields in that direction, turning, as it were, upon a centre at G; it is also made to slide in a groove made in this stud, in such a manner that the end *o* may be placed at any required distance from the centre of the verge.

Having described the several parts as they appear in the figure, we next come to their connection or situation with respect to each other. Let the long spring EF be supposed to be so placed, that the end of the slender spring γ *i*, may project a little way over the point of the lifting pallet *i n*, but not so close but that the point of the pallet may pass by the hooked end of the spring EF, without touching it; the head of the adjusting screw *m*, is also supposed to bear gently on the inner side of the said spring EF, or that side nearest to the wheel; and at the same time, the locking-pallet is so placed that one of the teeth D, of the balance-wheel, may just take hold of it. This pallet is not visible in its proper place in the figure, being covered from sight by the screw *m*, and part of the spring EF; its position is therefore represented by the dot *k*, on the opposite side of the wheel, having the tooth A just bearing up against it. From the above description of the several parts of the escapement, and their connection with each other, it will be easy to see the mode of its action, which is as follows:

A force being supposed to be applied to the balance-wheel, so as to cause it to move round in the direction of the letters

ABCD, one of the teeth, as D, will come up against the locking-pallet, (as represented at A, and the locking-pallet by *k*.) The wheel is then said to be locked, being prevented from moving forward by this pin. Let the balance now be supposed to rest in its quiescent position, and it will have the situation represented in the figure; the lifting point *i*, of the pallet *i n*, will be just clear of the projecting end of the slender spring; the face *h l* of the large pallet MSK will fall a little below the point of the tooth B, and the balance having its spiral or helical spring applied to it, (which is here supposed on the other side of the plate PQRS, and of course not visible in the figure,) remains perfectly at rest in this position. Now as the balance ULHV, and the two pallets MSK and *i n*, are fixed fast to the verge, it is plain they must all move together; let, therefore, the balance be carried a little way round in the direction of the letters VULH; by this motion the end *i* of the lifting pallet *i n*, will be brought to press up against the projecting end of the slender spring, and as this spring is fixed on the side of the spring EF, nearest to the balance-wheel, the point *i* will press the two springs together out from the balance-wheel; then, as only the point of the tooth D (see its position at *k*) touches the locking-pallet, when the spring EF was at rest against the head of the screw *m*, it will, by the spring being pressed out from the tooth, have slipped off: (for the locking-pallet, which was before supposed at *k*, will now be at *a*, clear of the tooth A of the balance-wheel;) the wheel being now at liberty, will move round by the force supposed to be applied to it; but as the point *i* of the lifting pallet moves on, and presses out the spring, the point *l* of the large pallet approaches towards the point of the tooth B of the balance-wheel, so that when the spring EF is sufficiently pushed out to unlock the wheel, the point *l* of the large pallet will be got to *d*, and in this position the point of the tooth B of the balance-wheel will fall upon it, see fig. 2, where the tooth B is represented in contact with the pallet at *l*; at the same time the point of the tooth D has just dropped off from the locking-pallet *m*; the force of the wheel being by this means applied to the top of the pallet *h l*, gives an increased momentum to the balance, and assists it in its motion in the same direction; and by the continued motion of the large pallet in the direction MSK, the point of the tooth B, which keeps pressing and urging it forward, moves up towards the bottom of the face of the pallet towards *h*, until the plain

flat surfaces of the tooth and pallet come into contact, see fig. 3; by this time the end *o* of the slender spring has dropped off from the point *i* of the lifting pallet, and the two springs have returned again into their quiescent position, the spring EF gently bearing against the head of the adjusting screw *m*, and the locking-pallet in a position to receive the next tooth C of the balance-wheel; (see the position of the point of the lifting pallet at *i*, fig. 3, also the locking-pallet at *m*, and the approaching tooth at C.) When two surfaces of the tooth and pallet are thus in contact, the greatest force of the wheel is exerted upon the pallet, and of course upon the balance moving with it. The tooth still pressing against the face of the pallet, and the pallet moving in the direction MSK, it at last drops off, (see fig. 4, where *m* represents the position of the locking-pallet, C the position of the tooth of the wheel, just before it drops upon it, and *l h* the position of the face of the large pallet, having the point of the tooth B, just ready to leave it at *l*,) leaving the balance at perfect liberty to move on in the same direction in which it was going. Just as the point of the tooth B which has been pressing the large pallet round, is ready to leave it, the next tooth C of the wheel is almost in contact with the locking-pallet *m*, (see fig. 4,) so that the instant the tooth B drops off, the wheel is again locked, and the action of that tooth upon the balance is finished. As the balance moves with the greatest freedom upon its pivots, the force of the tooth has given it a considerable velocity, so that the balance still keeps moving on in the same direction, after the pressure of the tooth is removed by slipping off from the pallet, until the force of the pendulum-spring (which is not represented in the figure) being continually increased, by being wound up, overcomes the momentum of the balance, which, for an instant of time, is then stationary, but immediately returns, by the action of the pendulum-spring, which exerts a considerable force upon it in unwinding itself. As the balance returns, the point *i* of the lifting pallet *i n*, passes by the ends of the two springs EF *γo*, and in passing by, pushes the projecting end *o* of the slender spring, in towards the balance-wheel, until it has passed it; which, as soon as it has done, the projecting end *o* again returns, and applies itself close to the hooked end of the spring EF, as before. The spring *γo*, is made so slender, that it gives but little resistance to the balance, during the time the point *i* of the lifting pallet is passing it, and of course, causes but

little, if any, decrease in its momentum. During the time the point *i* of the lifting pallet is passing the small spring *γ o*, the long spring EF remains steadily bearing against the head of the adjusting screw *m*, as the hooked end at *o* just lets the ends of the lifting pallet pass by without touching it. As the spring has now been continually acting upon the balance, from the extremity of its vibration, in the direction MSK, it has given it the greatest velocity, when the point *i* of the lifting pallet is passing the end *o* of the slender spring; for at this instant, the spring which was wound up by the contrary direction of the balance, is now unwound again, or in the same state as it was in its quiescent position at first, and of course has no effect upon the balance at all, in either direction; but the balance having now all the velocity it could acquire from the unwinding of the spring, goes on in the direction UVHL, until the force of this spring again stops it, and brings it back again, moving in the same direction as at first, with a considerable velocity. By this return of the balance, the point *i* of the lifting pallet comes up again to the projecting end *o* of the slender spring, pushes back the long spring EF, and unlocks the wheel; and another tooth falling upon the face of the pallet *h l*, gives fresh energy to the balance; and thus the action is carried on as before.

The Board of Longitude, for the information of the public, and previous to their making a final award of recompense, were desirous of obtaining the most complete information on the construction and principles of the timekeepers in question; they therefore put several questions to the Inventor, on such points as appeared capable of further elucidation. These questions, with the answers made to them, we here subjoin, as they will afford information which may be useful. In the original, some confusion arises, by incorrect references to the pages; but we have endeavoured to adapt the references to these pages, in the manner intended:

Quest. Page 368, line 11. Explain this?

Ans. I do not know any words in the English language that can explain this better than the words I have used in my specification.

Quest. II. There are certain best sizes for the scape-wheel detent and pallets, in proportion to that of the balance. What are they?

Ans. The sizes for the scape-wheel detent and pallets, in proportion to that of the balance, are given in plate LV. fig. 2, where the exact size of balance may be seen; and in fig. 9, are the sizes for the scape-wheel detent and pallets.

Quest. III. Page 363, second paragraph. Are you here describing a box or pocket-timekeeper? What should be the respective sizes of the pivots of the balance-axis for each.

Ans. The whole of my specification is on box-timekeepers, for the determination of the longitude; I have nothing to do with inferior articles, which pocket-watches are; but I have no objection whatever to give the fullest explanation on them. Therefore, the size for pivots of balance axis for box-timekeepers is, as I have before described it in my specification, viz. about the size of the verge-pivots of a good common-sized pocket-watch. The pocket-timekeepers a very little smaller. No description can be given that the Trade are so well acquainted with as this.

Quest. IV. Page 364, line 16 to 26. Explain this?
line 33—4. Explain this?

Ans. Line the fourth, to the end of the paragraph, cannot be better explained but by examining the model, and showing it in action; which I shall be very willing and ready to do, at all seasonable hours, to any person or persons, except some of the watchmakers, who are my declared enemies.

Quest. V. Page 364, line 42. What is the diameter and weight of the balance for a given main power, and likewise for a certain number of vibrations, viz. 18,000 in an hour, which is essential to determine, as it would serve as a general theory.

Ans. The diameter of balance is given in plate LV. fig. 2, in proportion to a given main power, in the same plate, and under it letter *b*. After any one has made it as described in this plate, let him put it into a scale, and the weight will appear. Then, if he looks into the specification, page 369, he will find every thing relative to the train. Those who ask this question have either blinded themselves, or they have not read my specification. However, the diameter of the balance without the weights and screws, is one inch and one-eighth, with them one inch and three-eights. Weight of it, with compensation weights and screws, 3 dwt. 10 grains. Diameter of barrel which contains the main-spring, or first

maintaining power, one inch and one-eighth and one sixteenth; height of it, half an inch. The spring therein contained, four and a half or five turns, which is an unerring guide for any one.

Quest. VI. Page 365, line 4. What is the thickness of the steel rim of your balance, in thousandths of an inch? And what the size of the pivots of the balance-axis, and of the pivots of the scape-wheel?

Page 365, line 8. What is the weight of one of these screws?

Ans. The thickness of the steel rim of the balance is about eight-thousandths of an inch, the size of the balance-pivots the same, as near as I can measure; but the watchmakers are better acquainted with the thickness I before described in my specification, page 365, lines 3, 4, and 5. The scape-wheel pivots should be the least matter larger than the balance-pivots. The weight of one of the balance-screws should be about five or six grains, a little more or less is not material.

Quest. VII. Page 365, line 12. What must be the size of the piece of brass from which the compensation weights are to be cut for box and pocket timekeepers?

Ans. The size is given in plate LV. fig. 2, where the compensation weights may be seen fixed on the balance, and those weights are separately shown in figs. 11 and 12, so that no one can be at loss for them.

Quest. VIII. Page 365, line 33. Do you blue your balances? And if you do so, do you make any alteration to them afterwards?

Ans. I do blue the balances, but make no alteration afterwards.

Quest. IX. Page 366, line 4. As bending is condemned, what method do you use of restoring your balances to their circular figure after they have been cut open, as the circular figure is thereby lost, and the rims sometimes close, and at other times open?

Ans. I do not restore them to the figure they had before cut open, but blue them after cutting open, to preserve the natural figure they then take.

Quest. X. Page 366, line 19. What is the equivalent weight of one of the compensation weights?

Ans. About twenty grains; a little more or less is not material.

Quest. XI. Page 366, third paragraph. What internal defects occasion a watch to measure time differently in different positions? What position should the pallet of the balance have when at rest? And what is the effect produced by placing it in different positions?

Ans. Large balance-pivots; because when the timekeeper is in a horizontal position, the pivot than acts on its point, but in a vertical position they act on their sides, which is an increase of friction, the balance cannot then vibrate so far as when horizontal. Another cause of error in different positions is, when the watch is in the position that the balance is under the scape-wheel, its vibrations will be different to those when in the position which places the balance over it; and if the long and short vibrations are not performed in the same time, or nearly so, the watch must vary in the different positions, from that cause, and other causes too absurd for me to write on, as they are well known to the Trade.—When the balance is at rest, the face of the pallet should stand exact to the point of the wheel-tooth, as in plate LV. fig. 9.—If you place the face of the pallet without the tooth of the wheel on the right hand side, then, when the wheel is unlocked, it will fall on the round of the pallet, instead of the face of it, and cause a considerable rubbing; and if placed more within the tooth, it will have too much drop, a term in scapements with which all watchmakers are well acquainted. This can be better explained by the model in action, or by examining the drawing of it.

Quest. XII. Page 366, line 35. When the weight is wanted to adjust the watch in the positions of 3 and 9, by what means do you obtain that weigh, in the manner your balance appears to be made? If you know any thing more that is material, concerning the making timekeepers go nearly the same in different positions, communicate it?

Ans. To adjust the watch in positions of 3 and 9, I fix to one of the compensation weights that is downwards, when in that position that it loses most, a small piece of brass not larger in diameter than a common pin-head, and nearly as thin as foolscap paper. I fix it on with a very small particle of bees' wax, not larger than the common dot of an i; that is, if the watch is gaining on mean time. But if the watch is

losing. I then take out the balance, and, with a drill, drill out a small matter from that compensation weight that is uppermost when in the position that the watch loses most; this I have found to correct it, without so many screws and fans as I have seen in some timekeepers.

Quest. XIII. Page 367, first paragraph. What is the length of the balance-spring in your box-timekeeper, and what in your pocket-timekeeper?

Ans. About the usual length of Arnold's, various as his are, from 12 to 20 inches in box-timekeepers, and in pocket ones from 5 to 7 inches, just as I can get the wire to answer the purpose.

Quest. XIV. Are your balance-springs made of soft steel, or tempered? And if tempered, in what manner?

Ans. My balance-springs are made of soft steel, rolled hard, and not hardened with heat and cold, that process not being at all necessary.

Quest. XV. How is the balance-spring turned into its proper shape?

Ans. It is turned round a brass cylinder, and then blued by heat, which sets it into the cylindrical form.

Quest. XVI. Page 367, line 27. Explain what you mean by this? And how it is performed?

Ans. All watchmakers know how to draw and taper balance-springs, though they did not know how much they were to be tapered to that certain degree which could only answer the purpose of a complete timekeeper. I perform it in the following manner:—Take a length of balance-spring wire, say about 12 inches for box-timekeepers, and draw it between two smooth potence files, beginning from the end about one-sixth of its length, make one draw; the next about two-sixths; and so on, advancing one-sixth every draw, till you come to the top, pressing the files just so hard together as will make them bite or take hold of the spring; do the same with two oil-stones, only give twelve strokes instead of six, which will take off all burs which the file left on.

Quest. XVII. Page 367, line 3 from bottom. As you say that the balance-spring will continually lose of its power by

use, is there any method of restoring it to its original strength? And what?

Ans. By giving it rest.

Quest. XVIII. Page 368, line 10. Be pleased to explain clearly and fully the proper shape of the spring, and your manner of making it, to produce the effect here described?

Ans. This is fully explained in my answer to the XVIth question.

Quest. XIX. Page 368, lines 14 and 15. How is the watch made to vibrate one-third of a circle, or a circle and a quarter, or confined to a circle and a quarter?

Ans. Make the timekeeper in all its parts as described in plate LV, and it will produce this vibration, one circle and a quarter; if not so much, the balance must be lightened, or a stronger main-spring put in, whichever is most convenient; but if it vibrates more, then turning the small pallet a little nearer to the face of the large pallet, so as to give the scape-wheel a little more drop, will shorten the vibrations: or setting the detent-spring in a little stronger, will likewise shorten them.

Quest. XX. Page 368, line 13 from the bottom. If a spring, after being applied to a timekeeper, is found not to render it correct, can the same spring be altered to correct it? And if so, how performed?

Ans. It may be altered, but I advise making another. Every beginner must expect to have some little loss at first; but in a short time, by habit and attention, he will be able to make them so near, that if they are not quite exact, they will be exact enough for timekeepers of inferior prices, and the maker will be able to accommodate various purchasers who will not give the highest price.

Quest. XXI. Page 368, line 6 from the bottom. Does altering the length of a balance-spring, of uniform thickness throughout, alter the performance of a watch in any other way except that of making it gain or lose on mean time?

Ans. I never used the lengthening or shortening the spring for any other purpose but that of making the watch gain or lose. Le Roy published, many years back, that a certain length would produce isochronism; and Arnold says, he has

used it for that purpose. I use a method truly English, contrived by myself, and produce isochronism by tapering.

Quest. XXII. Page 369, second paragraph. Explain this?

Ans. My scape-wheel is locked on the extremity of it, and unlocks in a similar circle which the wheel makes, which renders it a perfect dead scape. Arnold's is locked on the other side of the wheel, and in the act of unlocking the spring moves in towards the centre of the wheel, which is a different direction to that which the wheel takes, and produces recoil. If the watchmakers cannot understand this, it is clear then that I have told them something. My scape-wheel, being locked on the extreme point, is easier unlocked than Arnold's, which is locked nearer the centre. Peto acknowledged, in the presence of Frodsham, many years back, that the above two circumstances were a great cut upon Arnold, and in consequence proved my scape to be superior to his.

Quest. XXIII. Page 370, line 5 from the bottom. Explain this? Line 4 from the bottom. Explain this?

Ans. This is fully explained in No. XXII, above.

Quest. XXIV. Are the timekeepers No. 520 and No. 543, made by you for the Board of Longitude, complete specimens of your improved timekeepers?

Ans. They are, as near as necessary.

Quest. XXV. Description of the timekeeper, pages 371 and 372. How are your plates to be understood, with respect to the sizes of the parts of your box-timekeeper, and pocket-timekeeper?

Ans. I before observed, that I had nothing to do with pocket-timekeepers; but if any watchmaker wants their sizes, they ought to know them from the box ones, as set forth in my specification; if they do not, they may see them in any of my pocket-timekeepers, as I have turned out hundreds of them, and with which they are well acquainted; and if further explanation is wanted, it can be better given to them by exhibition, which I have before promised to give.

Quest. XXVI. Page 373, line 26. Is there any particular nicety in making the detent-springs? How are they brought to their proper shape?—hardened, tempered, &c. What altera-

tion will take place in the performance of the watch, in consequence of any alteration in the stiffness of those springs?

Ans. As the detent-spring is to fall into the teeth of the scape-wheel, to stop it at every tooth, it should be no stronger than just necessary to do so; and such strength can be obtained by any watchmaker looking at one, and trying its strength with the finger; and indeed they can hardly make them too weak, so they do not cockle. They are brought to their proper shape by files, and afterwards smoothed with a piece of steel and oil-stone powder. I do harden and temper them. If the spring is stronger than necessary, it will produce friction, and impede the motion of the balance; for, as the swing of the balance is to unlock the wheel, by moving the spring out of it, it is sixteen times more easy for the balance to move a spring of the force of one ounce, than one of the force of one pound; therefore, a detent-spring too strong is a great evil, and they can hardly be made too weak; and it is perfectly easy in the making to find the right strength.

Quest. XXVII. Page 374, line 10. How should the lifting and large pallets be placed with respect to each other? And how are these pallets made and adjusted? As the unlocking of the wheel depends upon the relative situations of the lifting and large pallets, what alteration will take place in the performance of the watch by varying the positions of those pallets?

Ans. The lifting and large pallets are twisted on the same round axis, and may be moved with ease into any circular direction to each other; and the small lifting pallet must be moved round to such position, that when the wheel is unlocked the face of the large pallet should be just within the compass of the wheel tooth which is to act on it. The pallets are made of steel, and jewels set in them for the acting parts. The effect produced by not setting these two pallets right, is fully explained in the last part of my answer, No. XI.

Construction of Timekeepers for ascertaining the Longitude at Sea.

The chronometrical part of the timekeeper may be considered as confined altogether to the balance-spring, the balance, and the escapement. The other parts are no more than a good horizontal movement, which may be of any dimensions from two inches and a half in diameter, to five or more, and of proportionable depth, and may be constructed to go a day, a week, a month, or even a year, (though the last may not be quite so well,) at the option of the maker.

In plate LVII, fig. 1 exhibits a lateral view of a timekeeper of this construction:

A, the upper plate. B, the pillar-plate.

CCC, pillars, on the heads of which, above the upper plate, are collets and screws, to fasten the upper plate to the pillars, the other ends of them being riveted into the pillar-plate B.

DDD, the potence. EE, the cock. F, the fusee.

G, the great wheel acting in the centre-wheel pinion 3.

H, the detent-arbor and detent, which falls into the perpetual ratchet 2.

The fusee is constructed in the usual way, to keep the timekeeper going during the time of winding.

I, the centre-wheel arbor with the centre-wheel pinion 3, parallel to the great wheel G; and below the pinion, and partly under the great wheel, is the centre-wheel 4.

K, the third wheel arbor, with the third wheel pinion 5, below, in which the centre-wheel 4 acts, and under the pinion (which cannot be seen because it is sunk into the pillar-plate B) is the third wheel.

L, the fourth wheel arbor, upon which, partly under the potence, is the fourth wheel 6, and below that, and partly sunk into the pillar-plate, is the fourth wheel pinion 7, in which the third wheel acts.

M, the balance-wheel, or escapement-wheel arbor, whereon is the balance-wheel pinion 8, towards the pillar-plate, and in which the fourth wheel 6 acts.

At the other end of the same arbor, just under the upper plate, is the balance wheel, or escapement-wheel 9.

N, the barrel-bridge or cap, which is hollowed and raised above the upper-plate, to increase the height of the barrel W, which is under it, and which contains the main-spring.

10, The barrel-arbor square, upon which is a ratchet 11, just over the barrel-cap; and upon the barrel-cap is a click, (which cannot be seen,) and a click-spring 12. The ratchet, click, and spring, are placed in this situation, for the convenience of letting down or winding up the main-spring, by applying a key upon the square 10, for the purpose of decreasing or increasing its force, in order to try the long and short vibrations of the balance.

P, part of the fusee-arbor, on which, towards the top of the cock E, is a piece 13, like a cup, called the fusee guard, which, sliding upon 14, the square part of the arbor falls over the wind-up hole, to keep out dirt.

From Q to Q is the balance, more fully described hereafter.

R, the balance-spring.

n, The collet whereon the balance is screwed.

m, The balance-stud, between the balance and the spring, into one end of which the spring is pinned fast.

S, the plate-stud, or mouth-piece, screwed upon the upper plate, which opens or shuts as a vice, by means of the screw *r*, and by which the balance-spring may be lengthened or shortened at pleasure.

TT, the verge, the arbor, or the axis of the balance, passing from that part of the potence D, which is above the centre-pinion 3, to the top of the cock E, above the collet *n*. On this arbor is the impelling pallet 15, in the same plane with the balance-wheel 9, and in which the balance-wheel acting, occasions the balance to vibrate.

The small or discharging pallet cannot be seen, nor can the escapement or unlocking springs, as they are hidden by the thickness of the upper plate A; but the locking pallet *a*, may be observed between that plate and the escapement-wheel 9.

In this view the dial-plate 16 is at the bottom, and consequently the face of it cannot be seen, the timekeeper being turned upside down. It is, in the usual way, divided into hours, minutes, and seconds; the seconds-hand being carried upon the fourth wheel pivot. The hands appear below the dial-plate 16.

Between the pillar-plate and the dial, is the motion-work, made in the usual way.

The holes in which the axis of the balance move, and those of the balance-wheel, must necessarily be jewelled. The centre, third, and fourth wheel holes may also be jewelled.

The timekeeper is contained in a mahogany or brass case, with a glass over the dial-plate, and suspended in gimbals as a compass at sea. Or if it is adjusted to go alike in all positions, it may be put into a box stuffed with horse-hair cushions.

Were fig. 1 turned the other way, or the timekeeper in its proper position, which is horizontal, dial upwards, the balance would be at the bottom, below the balance-spring, near the cock E; and were the end of the spring out of the plate-stud S, the coils would all be close together as in fig. 5, and in contact with each other; the spring not appearing much more than half the height or depth which it does in fig. 1. The spring being extended by the weight of the balance, (which does not wholly rest on the jewelled end-piece which is set in the cock,) if the cock were to be taken away, the balance would remain suspended nearly in its present situation, and would drop very little lower than it now is. And as the spring is extended or drawn up, so will the weight of the balance be taken from off the cock, insomuch as even to bear considerably against the end-piece in the potence. In the timekeeper, the balance is made to bear a little on the cock; by this means, a considerable degree of friction is avoided, which must take place if the whole weight of the balance rested entirely on the end-piece without relief.

The method of suspending the balance by the spring is not followed in pocket chronometers. For in them there is no barrel-cap N, and the balance runs close above the upper plate A, on the middle of its axis, the balance-spring being between it and the cock; the cock being not so much as half of the present proportional height.

In fig. 2, 18 represents the tops of the pillars with the pillar-screws.

N, the barrel-cap; 19, the two screws which fasten it to the upper plate A.

11, The ratchet; 21, the click; 12, the click-spring.

14, The fusee-square; 13, the fusee-guard.

G, a portion of the great wheel which appears from under the plate.

B, the pillar-plate, projecting a little beyond the upper plate A.

16, The back of the dial-plate.

III. VI. IX. and XII. the four hours, three, six, nine, and twelve, (as the timekeeper is now placed face downward,) as a guide to explain the adjustment for position.

23, One of the screws which fasten the jewelled hole partly under the plate-stud S, in which the pivot of the fourth wheel runs.

22, The jewelled hole in which the pivot of the escapement-wheel runs, fastened by two screws.

9, The balance-wheel, which runs under the plate A; some of its teeth may be seen in the notch through the plate, the plain circle above only serving to show its situation below the plate.

EE, the cock, supposed transparent, to show the balance, the balance-spring R, and the balance-stud *m*, which crossing the centre of the balance, is marked by dots. The escapement-spring, which is hidden in fig. 1, may be here distinguished. Let *a* represent the end of the escapement-spring, screwed upon the upper plate A. From this end a notch is cut through the plate, which continues round the axis of the balance, and includes the impelling pallet 15:—17 is a rectangular hole, or notch, cut through the upper plate to admit the head of the adjusting screw, the top of which going through the solid part, between the two notches, touches the back of the locking-pallet.

What relates to the escapement will be treated of hereafter.

We shall next proceed to describe the balance-spring and balance, the drawings of which correspond in size with the timekeeper.

OF THE BALANCE-SPRING.

With the mode of rendering it isochronal, or of adjusting the long and short arcs of vibration of the balance. The terms long arcs and short arcs, large arcs and small arcs, are used indifferently.

The balance-spring may be made of steel-wire, hardened and tempered, of steel-wire hard rolled, or of gold-wire alloyed with copper. Steel-wire hardened and tempered is the most elastic, then gold, and lastly steel-wire hard drawn. Springs composed of any of the above substances, if the materials be good, will answer the purpose. The quantity of

copper-alloy put to the gold, has been found to answer in the proportion of from one-eighth to a quarter, and many other proportions may probably do as well.

The form of the spring is helical, or cylindrical, except for a portion of the turn at each end, where it is curved in, and fastened at an equal distance between its centre and circumference, which may be seen by inspecting one end at the stud *m*, and the other at the stud S, figs. 2 and 4. —It may also be observed in fig. 1, that the two end turns are curved in, or smaller than the others. Were not those turns to be curved inwards, but left of the same diameter with the others, the spring would not have its present easy, concentric motion, but on the contrary, would jolt, wabble, and be distorted. Whether the balance vibrates an arc of 230 degrees from its point of rest, in its forward direction, or revibrates 230 degrees in its backward direction, making together 460 degrees, the cylindrical figure of the spring is still preserved.

Upon the length of this spring depends the isochronism of the vibrations of the balance; and in every spring of a sufficient length, there is a place where all the vibrations, long, short, and intermediate, will be performed in equal times.

When the timekeeper is first set going, and always immediately after cleaning and putting into good order, the main-spring pulling with all its force, the oil applied to the pivots clean and good, and every part performing its functions to the greatest advantage, the balance may vibrate from 180 to 230 degrees from the point of rest, according to the power of the main-spring, and the relative weight of the balance. The balance also revibrates on the other side of the point of rest nearly the same arc, but here the vibration is only reckoned on one side.

From continual exertion, the main-spring will undergo some diminution of its original power; and very great resistance will be created from the thickening of the oil, and from the accumulation of dirt; so that at the end of a long voyage, suppose three or four years, the arc of vibration of the balance will gradually decrease from 230 to probably 130 degrees, and so on, till in time it will come to rest. From which it must be evident, that if the different arcs from 230 to 130 are not all performed in equal times, a great irregularity must from that cause take place. If the large arcs are performed in longer time than the small ones, the timekeeper will

accelerate, or go faster and faster; and if the small arcs are performed in longer time than the large ones, it will retard, or go slower and slower. To adjust the long and short arcs, let the timekeeper when clean, and the balance vibrating to its greatest extent, go for a few hours; and then, without stopping it, by means of the click and ratchet above the barrel-cap, and a key applied to 10, the barrel-arbor square, let the main-spring down a turn or two, till the arc of vibration decreases from 230 to 130 degrees, or thereabout. Then let it go for the same time as before, and if it goes slower with the long arcs than with the short ones, which is generally the case, shorten the spring, by drawing it through the lips of the stud S. Then try it again in the same manner, and so on, till they are performed in equal times.

If, on the contrary, the short arcs should be performed in longer time than the long ones, or the long arcs be performed in less time than the short ones, which amounts to the same thing, the spring must be let out, or lengthened at the stud S, and so on repeatedly, until they correspond. If after letting out the spring several times, there should be no more to spare, a longer spring must be made. The length of the spring in the timekeeper before us is about 18 inches.

If the spring is made of hard rolled wire, and the construction should be such as not to leave room for a spring of the usual length, and one much shorter than ordinary should be required, it will be very liable to be overstrained; and if hardened and tempered, or of gold, to break. It will, however, be a good deal relieved and assisted by tapering, the tapered end being pinned into the stud *m*.

OF THE BALANCE.

And the mode of making it to keep the same time in different degrees of temperature, or of adjusting it for the effects of heat and cold.

The cock E, see plate LVII, fig. 2, supposed to be transparent, that it may not prevent the balance from being seen.

Let *b b* represent the arms of the balance, which are broken off toward the centre, to give a view of the spring, the pallets, &c. The balance is screwed upon a collet *n*, fixed on the end of the axis, (see fig. 1.) At the extremities of these arms are two shoulders *c c*, against which, by

two screws, are fixed the expansion or compensation pieces *d d d*. These expansion pieces are composed each of two laminæ, the outside being of brass, the inside of steel. These two pieces are made out of one, the brass being melted upon the steel all in one piece. It is afterward cut into two.

d e, The steel laminæ continued, but made round, and tapped; *g g*, brass balls or weights, alike in all respects, made to screw upon each tap. In the sides of these balls are two holes between the centre and circumference, made to receive a tool like a two-pronged fork, called a fork-screw-driver, to screw the balls higher or lower.

f f, two side screws to assist in making the balance of an equal weight.

h h, screws to regulate the mean time, and which are tapped into the shoulders *c c*, passing through the expansion pieces.

The long and short vibrations being adjusted, we shall next show how to make the timekeeper perform alike in heat and cold. The balance-spring becomes weaker by heat, and stronger by cold; and were the balance to remain of the same diameter, it would go slower in heat, and faster in cold, supposing it to go to time when the thermometer stood at temperate. But when the spring becomes weaker by heat, the expansion pieces move *toward* the centre of the balance, carrying with them the balls *g g*, by which the diameter of the balance becomes smaller, and relatively lighter. When the balance-spring becomes stronger by cold, the expansion pieces move *from* the centre of the balance, carrying with them the balls *g g*, by which the diameter of the balance becomes larger, and relatively heavier; and when, after repeated trials, the balls are properly placed, at equal distances on each tap, the diameter of the balance will decrease and increase, in the same ratio as the spring decreases and increases its strength. The following is the cause of the expansion pieces moving toward the centre by heat, and from the centre by cold. As the outside lamina of the expansion pieces is of brass, and expands or lengthens more by heat than the inside lamina of steel, to which it is attached; it will be easy to conceive how the brass forces the steel inwards; and as the same lamina of brass contracts or shortens more by cold than the steel, it is obvious that it must draw it outwards. (Were the lamina of brass placed inside, and the steel outside, the balance would expand, or become larger by heat, and con-

tract or become smaller by cold, and instead of compensating the error of the spring, it would add to it.)

The balls *g g* being made of equal weight, may be placed at the end of the taps at *e*; and if the timekeeper, being in a situation where the thermometer will rise to 100 degrees or more, should go faster than when placed in another situation where the thermometer will fall to 32 degrees or lower, it is a proof that the expansion pieces do too much, and that the balls are too heavy. Supposing this to be the case, screw the balls up close to the ends of the expansion pieces at *d*, and their effect will be less; because, notwithstanding the same degree of heat will occasion the expansion pieces to move inwards the same quantity, or to describe the same angle from *c*, yet the balls will move through less space at *d* than at *e*. For it is evident, that if they could slide up to the ends of the expansion pieces next to the arms of the balance, they would not move at all, or at least, their motion could not be discovered by any effect that it would produce. If the timekeeper still gains in heat, reduce the balls, and screw them up again to *d*. In the next trial, should it lose in heat more than in cold, contrary to what it did before, it is a proof that the expansion pieces do not do enough, and the balls must be unscrewed toward the ends of the taps at *e*, until it keeps the same time in heat as in cold. If the balls being at the ends do not do enough, and the timekeeper still loses in heat, increase their size until the adjustment is brought within the compass of the length of the taps, where there is generally room sufficient to correct for a minute of difference in heat or cold per day. By screwing the balls up and down, it may be soon seen how much of error two or three turns will correct in a given time, and by that means discover their proper situation.

OF POSITIONS.

Or the mode of adjusting the Timekeeper to go alike, or nearly so, in different positions.

The long and short vibrations being adjusted, and also the heat and cold, the Inventor next shows how to adjust the different positions. Let the two mean screws *h h*, see plate LVII, fig. 2, be supposed, when the balance is at rest, to

stand at those points, where the hours 12 and 6 are marked upon the dial-plate, and that the two side screws *f f*, stand at those points where the hours 9 and 3 are marked. If the timekeeper should go faster with the hour 12 highest or vertical, than with the hour 6 highest, screw in the screw *h* a little at the hour 6, and unscrew the opposite screw at the hour 12 the same quantity; if it should lose most in that position, do just the contrary. The same rule is to be observed with respect to the hours 9 and 3, by the two side screws *f f*. It may, however, happen, that the balance will not preponderate at either of these four points, or that the screws may not be sufficiently powerful to effect the purpose. In this case, for the position 12 and 6, unscrewing a little one of the balls *g g*, and screwing in the other, may succeed; but this method should not be practised in superior timekeepers, because by so doing, it will occasion one expansion piece to act more than it ought to do, and the other less, and destroy that equality of expansion, of weight, and of distance, which the very word *balance* informs us ought to be preserved. To remedy this inconvenience, another method has been contrived, by which the balance may be rendered of equal weight, while the balls, the screws, and every opposite part, are at equal distances from the centre. Let the balance be made with a light ring *x x x*, (as in fig. 3,) within the expansion pieces. Let there be three light equal weights *k k k*, which by a screw in each, may be fixed in any part of the ring; then having adjusted the long and short vibrations, and the heat and cold, and having the mean time screws at equal distances from the centre, and the balls at equal distances upon the taps, (there will be no occasion for side screws,) try the timekeeper in different positions, and in a very few trials, by moving the weights upon different parts of the ring, the positions may be adjusted very accurately. The weights may be brought all to the same part, and the balance made to preponderate in any given point, and none of the other adjustments will be affected by it; and the weights, upon whatever parts of the circle they may be, will still remain at an equal distance from the centre.

Having adjusted for long and short vibrations, heat and cold, and positions, it remains only to regulate for mean time. Should the timekeeper gain, increase the diameter of the balance, by drawing out an equal quantity of the two mean-time screws *h h*; and should it lose, decrease the diameter, by screwing in an equal quantity of the same screws. This

adjustment does not affect that for heat and cold, because these screws are unconnected with the expansion pieces; nor will they affect the positions, if they are both turned the same quantity, and the taps of the same thread.

OF THE ESCAPEMENT.

In plate LVII is very distinctly seen the relative position of the escapement to the other parts of the timekeeper. In this plate the balance and spring are upon a scale sufficiently large to be understood, without much difficulty; but the action of the escapement may not be so easily comprehended, as by a drawing upon a large scale.

Fig. L, plate LVIII, represents the escapement-wheel, the teeth of which are of a cycloidal shape, and their upper surfaces towards the extremity present to the view a triangular form, two sides of which are described by right lines, and the other by a cycloidal curve, which is the principal part of action, (some of these teeth appear through the notch in the upper plate A, plate LVII, fig. 2;) but the triangular part of the tooth is not so plain as in plate LVIII.

In this plan the whole of the escapement-wheel may be seen, and its situation on the arbor M, in plate LVII, fig. 1, may be referred to.

BB *d*, the escapement or locking-spring, screwed fast by its end C to the pillar D, and extending from C to *d* in the direction CBNB *d*. (In plate LVII, fig. 2, the end *a* of this spring is screwed upon the upper plate A, and the spring itself, with the locking piece, sinks into the notch cut through the plate. Upon taking a side view of the upper plate A, fig. 1, its thickness may be observed. Through this plate the locking pallet meets the escapement-wheel 9.) The centre of motion of this spring is between C and N, the part NB *d* being more substantial that the part CBN, and into which part, between N and B, is fixed the locking piece *a*; this locking piece, or locking pallet, whose acting surface is a jewel, (see also fig. 8, plate LVII,) placed between N and B opposite the end of an adjusting screw F, and below the escapement-spring, locks upon the anterior angle of the tooth 2, and upon every tooth in succession, suspending the motion of the escapement-wheel for a time, and leaving the balance to vibrate without interruption from any part of the machinery.

It is to be observed, that the triangular parts of the teeth of the wheel AAA, the wheel being hollowed or sunk, are raised above the periphery of the wheel to meet the locking piece *a*, so that upon viewing the wheel edgewise, see fig. 5, (and also 9, plate LVII, fig. 1,) the teeth will appear broader than the edge of the periphery *b*.

In fig. 1, the locking pallet *a* being in contact with the tooth 2, is not so well distinguished as in figs. 2, 3, and 4, where it appears very plainly over the periphery *b* of the wheel, in the interval between the teeth 1 and 2.

(Fig. 6, plate LVII, gives a view of the escapement-spring reversed, and fig. 7 explains upon a large scale the figure of the locking piece, which is angular, adjoining that part of the straight edge where the locking is effected. Were this angular part to be left square, like the opposite end, it might strike against the interior angle of the tooth, as the escapement-spring returns to its place against the adjusting screw, after having unlocked or discharged the wheel, but by being of this figure it clears itself.)

N *e*, the discharging or unlocking spring, which is attached to the escapement or locking spring at N, and passes under the adjusting screw F, a little beyond the end *d* of the locking spring. This discharging spring is made very slight and delicate.

F, the adjusting screw, supported by the pillar *g*, (and which in fig. 2, plate LVII, passes through the solid part of the upper plate, from the rectangular notch 17,) whose end is opposite to the locking piece or pallet *a*, on the contrary side of the escapement or locking spring, and by which the locking piece or pallet *a*, may be more or less advanced upon any tooth of the wheel; the escapement-spring BB *d* always pressing the locking pallet *a* against the end of the screw F, except at the time of unlocking the wheel.

o, The unlocking, discharging, or small pallet, whose part of action is a jewel. (The pallet, with its jewel, may also be seen above the impelling pallet, there marked 15, plate LVII, fig. 2.) When the balance is in motion, this pallet presses against the end of the discharging spring at *e*, and passing on in a direction from *e* to *d*, carries with it, for a short space, the discharging spring N *e*, and also the locking spring BB *d*, moving them both at the same time, and in so doing, carries the locking piece *a* from off the interior angle of the tooth 2, or any other tooth which may come into that situation, and leaves the wheel at liberty to impart its power

to the impelling pallet. But when the balance returns, and the unlocking pallet *o* repasses the discharging spring N *e* in a direction from *d* to *e*, it does not in the least disturb the locking spring BB *d*, nor, consequently, the locking piece or pallet *a*, but moves only, and for a short space, the unlocking spring N *e*.

HHH, the impelling or large pallet, whose part of action is at the angle *m*, where a jewel is placed. (This pallet and jewel may be seen in plate LVII, fig. 2, where it is marked 15.) Upon the exterior of this angle the pallet receives its impulse from the cycloidal part of the tooth of the escapement-wheel. The circumference of the pallet is incomplete, from a portion being cut away, to make room for the action of the teeth of the wheel.

X is a circular hole under the periphery *b* of the escapement-wheel, over the centre of which the tooth 2 appears, and the locking piece or pallet *a*. The two springs BB *d* and N *e* pass over it. This hole is made through the brass plate QQQQ, through which, by inverting the escapement, the manner in which the locking piece *a* holds the tooth 2 (or any other tooth in succession) of the escapement-wheel, may be seen. (This may be understood from figs. 6 and 7, plate LVII.)

The impelling pallet HHH is supposed to be vibrating freely from *r* to S; here it is perfectly detached, or at liberty from the escapement-wheel; as will be seen by observing that the unlocking pallet *o* is not in contact with the discharging spring N *e*, nor are either of the teeth 3 or 4 of the wheel in contact with the impelling pallet. The ballance or impelling pallet (for they are both upon the same axis as in plate LVII.) vibrating from *r* to S, the discharging pallet *o* comes in contact with the discharging spring N *e*, see fig. 2, (and from that instant is not detached or free, but in the act of escaping) and moving it in the direction from *e* to *d*, takes the locking pallet *a* from off the interior angle of the tooth 2, and sets the escapement-wheel at liberty for the tooth 3 to act upon the angle *m* of the impelling pallet. Here the tooth 2 will be seen to have passed the locking piece *a*, and the tooth 1 to approach it. The tooth 3, pressing the impelling pallet from *r* to S, and continuing to do so, as in fig. 3, where the centre of the escapement-wheel, the angle *m* of the impelling pallet, and the centre G of both pallets, form a straight line. This action of the wheel upon the pallet continuing, as in fig. 4, where the point of the tooth 3 is about to quit the angle *m* of the impelling pallet, the tooth 2 approaching nearer to the circum-

ference of the same pallet, and the tooth 1 advancing toward the locking piece or pallet *a*, against which it falls, and is held fast, as soon as the end of the tooth 3 quits the impelling pallet. Here the act of escaping ends, and the impelling pallet is again detached or unconnected with the wheel, and moves in free vibration as in fig. 1, for a certain number of degrees, until it is returned by the power of the balance-spring, and repasses from S to *r*, still independent of the escapement-wheel, or of any thing else, except the very little resistance which is encountered by the discharging pallet *o*, in repassing the discharging spring N *e*, which it does without disturbing the locking piece *a*, or consequently the escapement-wheel; and continuing for a certain number of degrees, is again returned by the balance-spring from *r* to S, when resuming its situation, it is prepared to act as before.

It may be proper to remark, that the action of the cycloidal tooth upon the impelling pallet is always the same in the beginning as in fig. 2, in the middle as in fig. 3, and at the end as in fig. 4; impelling the pallet with the same quantity of surface in action at all times, and at all times equidistant from the axis of the pallet. This, however, depends upon the tooth having the true figure.

From the foregoing description of the escapement, referring occasionally to the plates LVII and LVIII, the nature of the action of its different parts, and their arrangement in the timekeeper, may be understood.

The proper shape of the cycloid is found in the following manner: having a plate of smooth metal, fix upon it a piece of brass, the side of the intended escapement-wheel, which call the false wheel. Then take another piece of brass, the size of the intended pallet, which call the false pallet. On the circumference of the false pallet fix a fine steel point, and then rolling the false pallet upon the circumference of the false wheel, the steel point will describe a line on the plate, which will be the proper curve, in which shape the tooth must be cut by an engine. The larger the pallet in proportion to the escapement-wheel, the less sudden the cycloidal curve will be, and the smaller the pallet the more sudden; so that an escapement-wheel which has 15 teeth, with a pallet of a proportionable diameter, will have its teeth of a very different shape to those in a wheel which has only 12 teeth, because, in one case, the pallet is half the size, and in the other it is little more than one-third.

The size of the pallet depends upon the number of teeth in the escapement-wheel. The radius of the pallet should be equal to the distance between any two teeth of the wheel, and then their relative motion will be equal. If the wheel has twelve teeth, the radius of the pallet will be thirty degrees measured on the circumference of the wheel, and its diameter sixty degrees, measured in the same manner, which will make it half the size of the wheel. If it has thirteen teeth, the pallet will, in diameter, measure fifty-five degrees and a half; if fourteen teeth, fifty-one degrees and a half; and if fifteen teeth, which is the number generally applied to pocket timekeepers, it will be forty-eight degrees.

The marine timekeeper, which has just been described, is made to beat half seconds, the balance making 240 vibrations both ways in a minute. For if the balance-wheel has 15 teeth, the fourth wheel 80 teeth, and the balance-pinion 10 teeth, there will be 120 beats, or half seconds, in one minute.

It is also made with the escapement-wheel of 12 teeth, the balance-pinion having 7, and the fourth-wheel 70; consequently there will be 120 beats, or half seconds, in one minute, as before. It has been already remarked, that the pallet for 12 teeth must be half the diameter of the wheel; and for 15 teeth five-twelfths, or fifty degrees.

The pocket-timekeepers, that they may not be disturbed by motion, have what is called a quicker train, the seconds hand making 150 beats upon the dial, or 5 beats in two seconds. The escapement-wheel has 15 teeth, the balance-pinion 8 teeth, and the fourth-wheel 80, consequently there will be 150 beats in one minute, the pallet being 50 degrees in diameter, measured upon the diameter of the balance-wheel.

No mention has been made of the number of the teeth in the other wheels and pinions, as they are of little or no importance, and may be varied considerably.

In consequence of the decease of the Inventor of the timekeepers we have been considering, the following questions, with the same views as stated in the former case, page 377, were put by the Board of Longitude, to his Son, who furnished the preceding account:

Quest. 1. Page 388, lines 4, 5, and 6, from the bottom. Are all these three substances equally good, and applicable in all cases to box and pocket timekeepers? Or under what

circumstances are they to be separately applied? And what advantage arises from applying one in preference to either of the others? Does not flatting or rolling pendulum wire destroy its elasticity, by crossing the grain of the wire so rolled? If so, do you use any means of making the grain of the wire longitudinal? if you do, it is required to explain the method.

Ans. All these three substances may be equally applicable in all cases to box and pocket timekeepers. Springs made of gold and of tempered steel are attended with more trouble in manufacturing than those of hard rolled wire, and unless the gold is well compounded, and drawn or rolled perfectly sound, it is liable to break. In springs of tempered steel, the greatest care should be taken that they are in the first place hardened from end to end, and then they may be equaly tempered throughout. They will be more elastic than gold and perhaps better, excepting their liability to rust. Springs of hard rolled wire are the least elastic of the three, and are subject to lose of their elasticity, if made so short as either of the others may be. On this account, I leave then about a fourth part longer than the others; and if the materal be good, they will stand. They are made in less time, and with less trouble than either of the others; but liable to rust I do not know that flatting or rolling the wire destroys or impairs its elasticity, nor do I use any means to make the grain of the wire longitudinal.

Quest. II. Page 389, line 4. How are the above-mentioned balance-springs made; that is, how are they brought to, and known to be of a proper size, for each different watch; how turned into their proper shape, hardened, tempered, &c? Is it necessary to attend particularly to the evenness of the wire? And if so, how is it known to be of an uniform thickness throughout?

Ans. I do not *(from experience)* pretend to know the exact proportionable size of balance-springs. I have made chronometers with springs of the same length and material, some of them making or containing six or seven turns, others nine, ten, and even twelve, consequently differing considerably in size, and yet performing equally well. I should imagine that the best size would be such, as that the spring might impel the balance in the centre of percussion, which will be between the centre and circumference of the balance, according as the weight may be disposed.—The springs of hard

rolled wire are turned into their proper shape, by winding them on a cylinder or mould, and screwing each end fast. The cylinder being heated by a blow-pipe until the wire becomes blue, it is taken off, and the ends turned in by a pair of bending pliers, or by drawing them over a round broach. Gold springs are brought to their shape by the same process, only that the mould, which may be of steel, is made blue instead of the wire. Or if the mould is of brass, the screws which fasten the wire may be of steel; and when they become blue, it will be the same thing as if the mould were of steel.

Springs are hardened by being made red hot upon the cylinder, either by a blow-pipe, or small charcoal fire, and then immersed in water or oil, and tempered by heating the cylinder wth a blow-pipe until the wire becomes blue. There is a very great difference in steel: some sorts will be harder and more eastic at a blue than others at a yellow, and some again will bear letting down below a blue. It also happens sometimes, that the very same piece of steel is of a better quality in one part than another. The ends may be turned in by a pair of bending pliers made hot, or the mould may be cut down or spiralled at one end, for the first turn of the spring, and it will come off with that end ready turned in. The balance-stud, into which that end is fixed, may be made moveable, or to shift, that is, to lengthen or shorten, so as to meet the curve of the spring, and then fastened by two screws. The other end-turn of the spring might also be fashioned in the same way; but as it may require to be shortened, to find the isochronal place, the curve will be continually altering, and must be replaced by the pliers, so that it will probably be useless to do it by the mould.

I think it necessary that the wire should be as even as possible. I do not suppose that any wire was ever of an uniform thickness, but its deviation from uniformity may be known by drawing it through a parallel guage. The best way I know of to make it as uniform as possible, is to grind it between two planes of hard steel with oil-stone dust.

The chronometer, No. 36, which was tried by the Astronomer Royal, five and twenty years since, had, and still has, the same spring of tempered steel. Everard's chronometer, No. 68, had, and still has, the same spring of gold: and the marine chronometer, No. 82, had, and I believe still has, a spring of hard rolled steel. Experience is in favour of all three. The length of the spring of No. 36, pocket-chronometer, was about eight inches; No. 68, about the same; No.

82, marine chronometer, sixteen inches, and of equal thickness from end to end. I think the gold and tempered steel will retain their identity longer than the other.

Quest. III. Page 389, line 19. What is the necessary length of a spring, which shall contain that certain place? And how do you select that place or part from the whole?

Ans. That certain place is contained many times between the length of five inches and twenty, of and between which lengths, vast numbers of springs have been made. Those places are selected from the whole, by continually shortening, as fully described in the method of adjusting the long and short vibrations.

Quest. IV. Page 390, line 23. As you do not recommend tapering the spring, but in the case of there not being room enough for a spring of a sufficient length, is it necessary to have the balance-spring of equal breadth and thickness; or, in other words, of equal strength in every part? If that is the case, what means do you use to make it so, since scarcely any two following inches of the same wire, as it comes from the hands of the wire-drawer, are of the same strength, and that a spring made of it, without preparation, would be compounded of various powers?

Ans. I only recommend tapering for hard rolled wire, but where there is perfect, or great elasticity, there is no occasion for it. The best hard rolled wire will not require it, unless made very short and overstrained, as may be the case in flat and fashionable chronometers, where there is not sufficient room. The tapering is chiefly wanted at the bottom turn next the balance stud, which, from its spiral shape, is strained more than the cylindrical turns.

Wire drawn through the plates where the holes are gradually smaller, will be of more equal thickness than rolled wire, unless the mill is excellent, as for that purpose it ought to be. The wire should be as equal as possible; but none is perfect, and all springs are and will be compounded of various powers, so long as we remain short of perfection. We can only come near it.

Quest. V. Page 390, last paragraph. Is there any difference in the action of the expansion pieces, when constructed of brass and steel of different qualities? And if so, what qualities are best, and how chosen?

Ans. I make use of good flat steel, and good Dutch brass and having found it to answer, never tried any other.

Quest. VI. How are the expansion pieces turned into their proper and regular form? And how is the brass made to unite properly to the steel?

Ans. The expansion pieces are turned into their proper shape by a pair of hollow-mouthed pliers, and then heated to make them retain that form; and the brass unites to the steel by heat, without any solder ever having to my knowledge been made use of; at least, during the last three and twenty years.

Quest. VII. What should be the relative thickness of the brass to the steel? And how obtained?

Ans. I make the brass twice the thickness of the steel, which thickness enables the brass to bend the steel easily, and I obtain it by measuring as near as I can.

Quest. VIII. Will any difference arise in the final performance of the watch, if the steel is hard, soft, or tempered? or from being hardened, or left in its natural state?

Ans. I cannot speak as to the difference, because I have always left the steel soft.

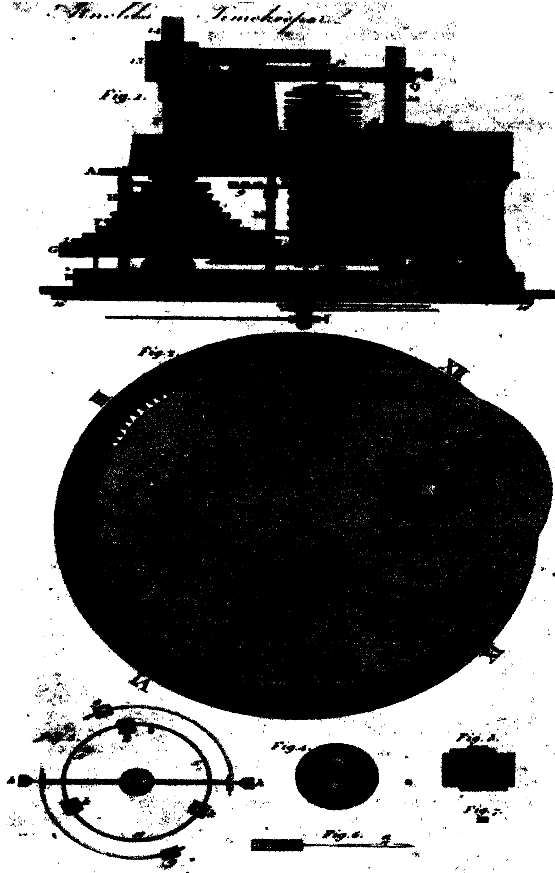
Quest. IX. Page 392, line 4 from the bottom. Why does a machine measure time differently in different positions? Is it a defect arising from the imperfect execution of the escapement or other parts of the machine? And if not, what other cause generates this sort of error?

Ans. Theoretically, from the unequal weight of the balance only; and if the escapement was void of friction, it would be practically so. With a good and well made escapement, the inequality lies almost altogether in the balance.

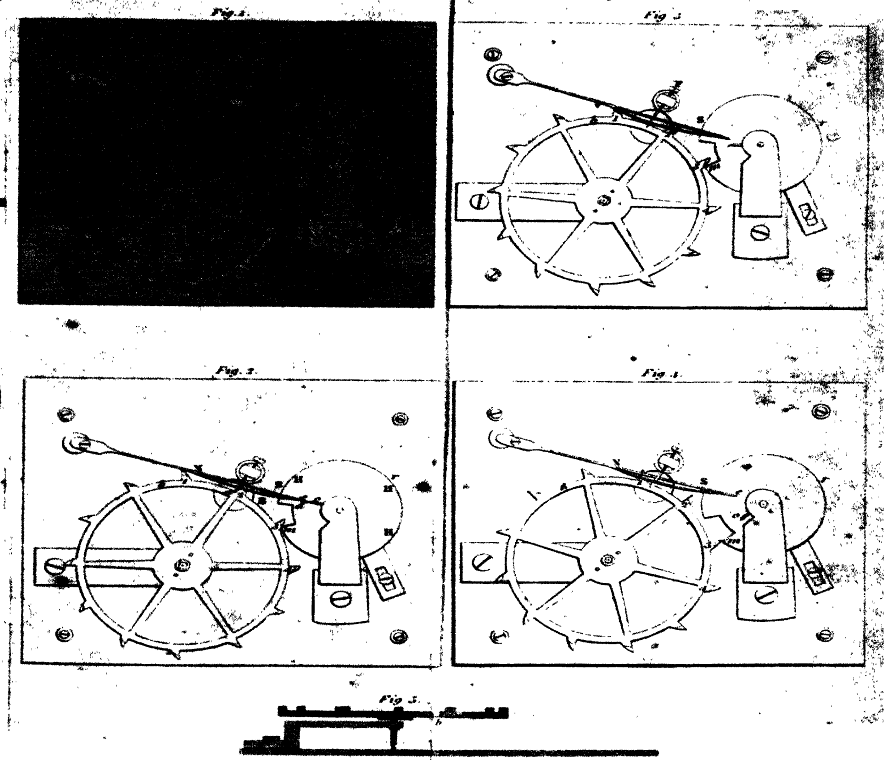
Quest. X. Page 392, last paragraph. How are the detent springs made and tempered, and placed in their proper positions? And what particulars are necessary to be observed in the making and placing them?

Ans. The detent springs are filed nearly to their proper substance, then hardened and tempered to a blue, sometimes not so low, according as the nature of the steel may be, and afterwards ground to their proper strength. The locking spring is then drawn nearer to, or farther from the verge, so

Arnold's Timekeeper.



Arnold's Timekeeper.



as to make the locking pallet hold each tooth of the wheel at an equal distance from the impulse pallet, after which it is steady pinned, so as it always may, if taken out, be returned to its place without further trouble. The unlocking spring is only to be in contact with the locking spring at the part where it is pinned fast, and at the end of the locking spring.

The spring should lock the wheel as light as possible, to do its duty, and the unlocking pallet should raise the unlocking spring as little as possible, to do its duty. The spring should point to the centre of the verge, and lift equally forward and backward. The end of the unlocking spring should be left rather stouter than the other part of it, to resist wearing.

Quest. XI. How are the lifting, locking, and main pallets made, and applied to their proper places? And what particulars are necessary to be observed in placing them, and how obtained?

Ans. The lifting, locking, and main pallets, are of steel hardened and tempered, with dovetails cut for the admission of jewels, of which their acting parts are composed. (*See the description of the Escapement.*) The situation of the lifting and main pallets to each other is such, as that when the wheel is unlocked, it may fall upon the main pallet before it comes to the line of centres, and to have as little drop as may be without butting.

Quest. XII. Page 397, line 16. Does the cycloidal tooth always act upon the outermost edge of the pallet, as it appears to do in the three figures representing its action on that pallet?

Ans. The cycloidal tooth does act upon the edge as it appears to do.

Quest. XIII. Page 399, line 13. Are the Timekeepers, No. 82 and No. 176, made by your father for the Board of Longitude, complete specimens of his improved Timekeepers?

Ans. No. 82 and No. 176, are not perfect specimens; they have been made about five-and-twenty years.

Repeating Watch, without Pinions, Pulleys, Chain, or Racks.

This watch will repeat the hour and the quarter, the hour without the quarter, or the quarter without the hour; the hour first and the quarter afterwards, or the quarter first and the hour afterwards, or the hour and the quarter without intermission, with one hammer only. The invention has met with the decided approbation of mechanical and scientific gentlemen; and a considerable number of the watches have been made for the Turkey, Irish, and American trade, as likewise for home consumption.

The great expense in the first purchase, and the continual expense of repairing repeating watches, induced the Inventor of the present plan, to turn much of his attention towards repeating mechanism, with a view to reduce it, if possible, to a much more simple principle, and so as to be afforded at a low price. In this undertaking, after a perseverance ot some years, he has been very successful. It is well know that repeating watches have always been, and are at this time, in the hands of few, and in such hands they appear to be more for show and amusement, than for any real use; but the middling class of mankind, to whom they would be of the most service, are deprived of their benefits. The simplification of them, is therefore certainly entitled to a favourable reception.

The method of using the new repeater is as follows:—Hold the watch in the left hand, and apply the finger and thumb to the pendant; and if it is required to repeat the hour, turn it to the right, till it gives a full stop. But if it is to repeat the quarter, turn the pendant to the left, till it gives a full stop, as in winding up a common watch.

The mechanism is represented by the figures 1 and 2, plate LIX.

Fig. 1, AB represents the upper side of the pillar plate.

CD, a circle of steel, moving freely in the friction rollers EF, and plates GH. This steel wheel is put in motion by means of a small wheel *a*, fastened on the axis which goes through the pendant, and it acts in the teeth of the circle represented at *b*.

I is the quarter-snail. K the minute wheel. The hour-wheel may easily be supposed, and therefore requires no description.

L is the pivot of the hour-snail, which is not drawn, as it would intercept the view of the rack of the steel circle at Q.

O is the locking lever. P the end which falls upon the hour-snail, to regulate the number of strokes it is to strike; at the same-time, the end Q of the lever O locks into one or other of the notches in the steel circle.

The star wheel, No. 1, is riveted or screwed to the hour-snail, and moved by the small arm, No. 2, on the canon pinion.

M and N are the jumper and spring.

R is the quarter locking lever. S the end which falls upon the quarter-snail. T the locking end, which locks into the notches at *h*.

At X is a pin in the steel circle, to which is hooked a chain, and the other end to the barrel V. This chain, when the pendant is put in motion, will unwind from the barrel, and, by acting between the steel rollers UW, will work both to the right and left.

i k, Are small pallets, on which are the tails of the hammers, acted upon by the pins as per figure, so that, at the end of the strokes that have struck, the spring in V will draw back the steel circle, and the pins will pass by the hammer-tail, and a small spring under *l* will bring it into its proper place.

When the watch is held in the left hand, and the right hand is used to turn the pendant to the left, to strike the hour, the point P will fall on some part of the hour-snail, at the same time the point Q will stop the steel circle. The hammer of course will give the hour. The same is to be understood of the quarters; only observing to turn to the right.

The following statement will show the advantage of the new repeaters over the old ones, for a period of twenty years:

	£	s	d	£	s	d
The expense of the old repeater, in the purchase.........	30	0	0			
Cleaning at half-a-guinea per year, for twenty years......	10	10	0			
				40	10	0
The expense of the new repeater, in the purchase.........	8	8	0			
Cleaning at 5s per year, for twenty years................	5	0	0			
				13	8	0
Advantage in favour of the new repeater,				37	2	0

The new repeating work can be added to an old watch for the sum of three guineas, if it is to be a dumb repeater; and for a further addition of three guineas, may be furnished new metal cases, and a bell to the repeating work.

Method of Banking a Timekeeper.

The banking of a timekeeper is of such real importance, that the most accurate instrument, without this necessary appendage, is liable to such derangement, that from the most trivial causes it is in one moment rendered useless. The utility of the particular contrivance now brought forward, to effect this purpose, has been fully verified by several years' trial, and has received the sanction of many of the most eminent watchmakers.

It was at first imagined, that a banking to a watch with a free escapement was quite unnecessary, as the limits of banking were so great as to admit of almost twice 360, or 720 degrees; but, on trial, it was found that the balance frequently exceeded this quantity, and that a very slight motion given to the timekeeper (particularly when the axis of the balance became the axis of that motion,) was sufficient to alter the strength and figure of the pendulum-spring, and position of the pieces in respect of the balance-wheel, so as to change the rate of the timekeeper; and, what was worse, a new adjustment of the balance was required, to accommodate it to the changes made in the spring, and other parts connected with it. Hence it became necessary that some means should be used to stop the balance at certain limits beyond its natural arch of vibration; and various attempts have been made to effect it. One way is, by a moveable piece on the axis of the balance, which banks against a pin, yet so as to suffer the balance to vibrate more than 360 degrees. Another method is, to have a piece moveable on a centre in one of the arms of the balance, and applying itself as a tangent to the pendulum-spring, which passes through a hole in the piece. It has also a knee, which almost touches the plate, and just passes free of a pin placed in it. But when the balance vibrates so as to approach its utmost limits, the action of the spring, while in a state of unwinding throws the piece outward, so as to fall in the way of the pin, and stop the balance from proceeding further. Another mode is by a straight spring, screwed upon the plate, having a hook at the end of it, into which a pin placed in the balance strikes, when, as before, the pendulum-spring, in unwinding, touches the straight spring, and moves it a little outwards. There is also a way of banking by means of a bolt, which is thrown back by the pendulum-spring, and made to fall in the way of a pin placed in the rim of the balance.

Elliot's Repeating Work for a Watch.

Fig. 1.

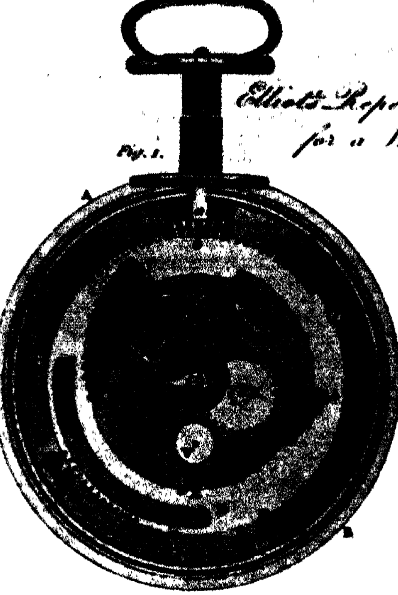
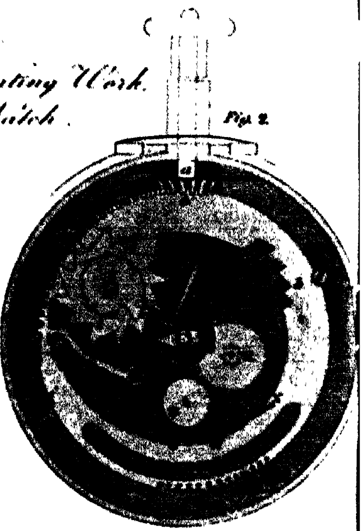


Fig. 2.



Hardy's Method of banking the Balance of a Time-keeper.

Fig. 3.

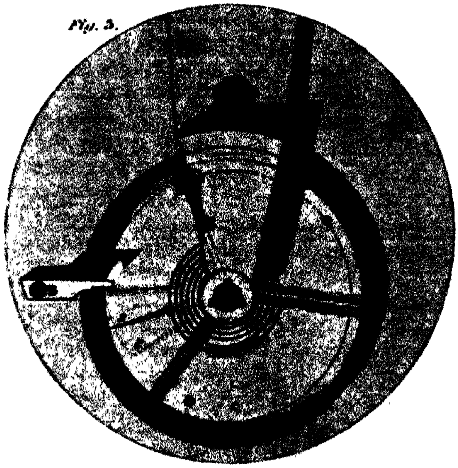
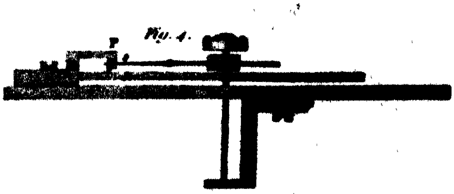


Fig. 4.



Published by Henry Fisher, Caxton, London, 1826.

These were the principal modes of banking in use, prior to the invention of the following one, and they did not differ materially from one another in principle. But the weight and friction of so many pieces, on so delicate an organ as that of a pendulum spring, are perhaps nearly as hurtful to the timekeeper as the injury it may sustain when it is left without any banking whatever.

In plate LIX, figures 3 and 4 represent the improved plan; the same letters are placed to signify the same things.

AA is the balance to which the pendulum-spring is fastened in the usual way.

In one of the crosses of the balance is placed a pin P, which stands a little way above its surface; and when the balance is caused to vibrate a complete circle, the pin in its motion will describe the dotted circle POQ, and just pass clear of the inside of a projection formed on a cock B, which is fastened on the plate by means of a screw.

At about one-fourth of a turn of the pendulum-spring, reckoned from its stud E, is placed a very delicate tapering piece of steel *s*, having a small hole in it, through which the pendulum-spring passes; and it is fastened to it by means of a pin, and stands perpendicular to the curve of the spring.

Let the balance be at rest, as represented by fig. 3, the banking pin at P, and the banking-piece at *s*. Suppose the balance is made to vibrate from P towards O, when P arrives at the banking piece *s*, it will pass it without touching, because its extremity, *s*, lies wholly within the circle traced out by the banking-pin. But when the banking-pin P has arrived at Q, the banking-piece *s* will have advanced to *t*, by the pendulum-spring winding itself up into the figure represented by the dotted curve; and when the banking-pin P (now at Q) returns back to P, and passes on from Q towards P. to approach B, and so complete the other half of its vibration, before P can arrive at the banking-cock B, the pendulum-spring will have unwound itself into the figure described by the dotted curve, and the banking-piece *s* will have advanced into the position at *r*, just touching the banking-cock. Its extremity *r*, however, being thrown beyond the dotted circle, must necessarily fall in the way of the banking-pin, which arrives there almost at the same moment, and is opposed by it, without the slightest shock to the pendulum-spring.

Permanent Compensation Balance for a Timekeeper.

We have at present two compensation balances: one sort consists of several slips of brass and steel soldered together, and disposed in the form of two S's on the balance; but this is now almost out of use. The other is a steel balance having a rim of brass soldered upon its outside, and cut open in two or three places, with sliding weights placed on the rim, to increase or diminish the effect of the balance. This balance (the only one at present much in use,) is very uncertain in its effects, and often requires adjusting. The Inventor of the plan now proposed, therefore rejected it altogether, and contrived a mode of applying the *direct* expansion of metals, which he found by experience to be constant and permanent in its effects.

The new balance consists of a flat steel bar, which forms its diameter. Beneath this steel bar are two metallic rods, secured at one end by a stud, formed out of the steel bar, and the other end acting on the short end of a lever, formed out of the other end of the same steel bar, being made to spring at the place where the centre of the lever would fall: to this lever is fastened a small cylindrical stem of brass, upon which a small globe of brass slides or screws; there is also a screw passing through the stem, to serve to regulate to mean time. Another metallic bar, equal and similar, and furnished like the other, but reversed in position, is placed parallel to it.

When the whole balance is heated, the metallic rods will push forward the short ends of the levers, a quantity just equal to the difference of the expansions of the two metals. Suppose the short ends of the two levers to be each equal to 1, and the long ends of the levers to be each equal to 20, then it is evident that the motion of each globe will be twenty times the excess of the steel bar and metallic rods nearer to the centre of the axis of the balance than before the expansion took place; and what is a very valuable and necessary property in the motion of the two globes, they will always move directly to the axis of the balance; that is, their action will be constantly in a plane, passing through the axis of the globes and of the balance. The globes may also be said to move in the same right line which passes through their centres, and cuts the axis of the balance at right angles; for the versed sine of a very small arch, or the difference between

the radius and co-sine, is in this case a quantity so small that it cannot be perceived; and however we increase or diminish the expansion of the balance, or whatever may be the degree of temperature, it still retains this admirable property, namely, that the two spherical weights move not only in the same plane in a strict mathematical sense, but also in the same right line in a physical one. This quality, united with the direct motion of the brass bars, renders the motion of the globes simple and uniform, and therefore the effect (depending upon such simple and direct causes) is regular and certain.

To increase or diminish the expansion of the balance, will be only to slide or screw up or down the globes upon their stems, until the balance produces the desired effect.

The rim of brass and steel of the common compensation balance, however intimately connected when first fluxed together, are by every change of temperature endeavouring to break the connection; and do by little and little tear themselves asunder, at least in a partial degree, for the fracture is often visible, so that the balance has nothing permanent in its nature. New adjustment is necessary much oftener than the instrument requires cleaning; but that adjustment is of no duration; for as the pores are more torn than at first, the balance becomes worse and worse, and at last will not answer the purpose intended in any degree.

The common balance, also,. when in motion, causes the weights to fly off or recede from the axis of the balance, and this flying off will increase and diminish with the arch of vibration in the balance; for as there is nothing to brace the rim at the extremity of which the weight is suspended; as the arch of vibration increases, the weight and rim are thrown outward as much as the centrifugal force of the weight exceeds that of the elasticity of the rim; and as the arch of vibration diminishes, and consequently the centrifugal force, the weight is thrown inward by the elasticity of the rim.

The weights or spheres of the new compensation balance, are firmly braced in every degree of temperature, and consequently not influenced in the smallest degree by any change in their centrifugal forces; hence this balance derives a title to the appellation of *permanent*.

The great difficulty in constructing a balance, and in applying the direct expansion of metals, is to contrive it so that it shall preserve its equilibrium in every degree of temperature, and also admit of having all its parts made perfectly equal and similar by mechanical means. The acquisition of

these important points the Inventor has attended to with great success.

Figs. 1 and 2, plate LX, represent the new permanent compensation balance. The dimensions of the several pieces are expressed in inches and decimal parts of an inch.

Fig. 1, AA, two globes, which slide on the cylindrical stems of two upright levers and are fastened by screws, by which the effect of the expansion is increased or diminished.

CC, two equal and similar screws by which the watch is adjusted to mean time.

DD, the verge or axis of the balance.

EE, the combination of the steel bars with the brass bar.

Fig. 2, SS, the steel bar, whose length is	1.600
Its breadth	0.232
Its thickness	0.032
BB, two similar and equal brass bars, in length each	1.470
In breadth . .	0.078
In thickness .	0.032
Length of the two springs formed out of the steel bar,	0.030

Among those who highly approve of the preceding invention, and are competent judges of the subject, it is particularly acceptable to find that one is William Nicholson, Author of the Chemical Dictionary, &c. He considers the invention excellent, and gives the following view of his reasons :

First.—The invention of confining the flexure of the steel bar to a small part near the end, is new, and no less remarkable for its ingenuity and simplicity, than for the steady effect it produces.

Second.—The whole combination is particularly firm ; and as the workmanship depends upon faces which are either plain or turned in the lathe, it can very easily be manufactured without requiring uncommon skill in the workman.

Third.—As it has neither working surfaces of contact, nor joints nor levers, it will regularly obey the minute changes of temperature, and will not act by jerks or starts.

Fourth.—In the expansion-bar consisting of two metals, connected longitudinally by soldering or otherwise, the differences of length between them, when heated or cooled, are found to produce a bending of the whole bar, which is more, the thinner its component parts. At the very surface of contact, and at a considerable distance on each side of that surface in thick bars, the principal effect must consist in what workmen would call wire-drawing the one metal, and upsetting the other. It is reasonable to think that this process

must affect the properties of a balance so constructed, and cause it to deviate in the course of time from its original adjustment. This objection to the common expansion balance appears to be obviated by the new invention, in which the flexure of the brass takes place through its whole length, in a regular manner, and is in quantity but small; and the flexure in the reduced parts of the steel bar will be equally slight, if the thickness of that part be made to bear the same proportion to its length Hence, and upon the whole, it may be concluded, that when once it is adjusted, it will not alter, and that in all changes of temperature it will be similarly affected, and will return to its original figure whenever the first temperature is restored.

Fifth.—Artists will probably consider it as a desirable property of the present instrument, that the adjustments for temperature being made in lines nearly parallel to the verge, will have no practical effect in deranging the adjustments for position.

Escapement for a Watch.

This escapement the Inventor contrived under the idea that the giving of an equal impulse to the balance contributes more than any other general cause to the perfection of chronometers. It has not only the property of correcting the errors of the main-spring, train of wheels, &c. and giving an equal power to the balance, but likewise the wheels are locked, without spring-work, perfectly safe from getting out of order, and are unlocked by a power exceedingly small, as the wheels do not bear against the locking with more than a tenth part of the whole pressure from the main-spring. The train of wheels is prevented from pressing against the locking, by the whole power of the remontoire spring; so that the balance has only to remove the small remaining pressure. The locking may be compared to a light balance turning on fine pivots, without a pendulum-spring; and has not only the advantage of banking safe at two turns of the balance, and of being firmer and less liable to be out of repair than any locking where spring-work is used, but likewise of unlocking with much less power. The whole work has besides the recommendations of simplicity and of not being expensive.

A, fig. 3, plate LX, the scape-wheel.

B, the lever-pallet, on an arbor with fine pivots, having at the lower end

C, the remontoire or spiral spring fixed with a collar and stud, in the same manner as pendulum-springs.

D, the pallet of the verge, having a roller turning in small pivots for the lever-pallet to act against.

E, pallet to discharge the locking, with a roller between, as in fig. 6.

F, the arm of the locking pallets continued at the other end to make it poise, having studs and screws to adjust and bank the quantity of motion.

a and *b*, The locking pallets, being portions of circles, fastened on an arbor turning on fine pivots.

G, the triple fork, at the end of the arm of the locking pallets.

The centre of the lever-pallet may be in a right line between the centre of the scape-wheel and the centre of the verge, or not, as best suits the calliper, &c.

The scape-wheel A, with the tooth 1, is acting on the lever-pallet B, and has wound up the spring C; the verge-pallet D (turning the way represented by the arrow) the moment it comes within reach of the lever-pallet, the discharging pallet E, taking hold of one prong of the fork, removes the arm F. and relieves the tooth 3 from the convex part of the lock *a*. The wheel goes forward a little, just sufficient to permit the lever-pallet to pass, while the other end gives the impulse to the balance: the tooth 4 of the wheel is then locked on the concave side of the lock *b*, and the lever-pallet is stopped against the tooth 5, as in fig. 7. So far the operation of giving the impulse, in order again to wind the remontoire spring, (the other pallet at E, in the return, removing the arm F in the contrary direction,) relieves the tooth 3 from the lock *b*.

The wheel again goes forward, almost the whole space from tooth to tooth, winds the spiral spring again, and comes into the situation of fig. 3, and thus the whole performance is completed.

The end of the lower pallet B resting on the point of the tooth 1, prevents the wheel exerting its full force on the lock *a*, as in fig. 3. The same effect is produced by the pallet lying on the tooth 5, by preventing the wheel from pressing on *b*; and thus the locking becomes the tightest possible.

This escapement may be much simplified by putting a spring with a pallet made in it, as in fig. 7, instead of the lever-pallet and spiral spring. The operation will be in other

Hardy's Compensation Balance.

Fig. 1

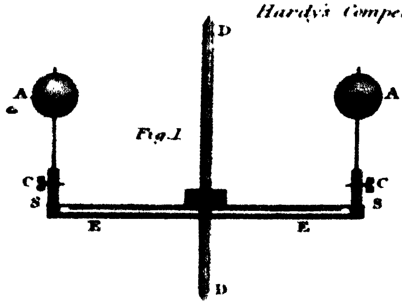
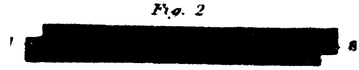


Fig. 2



De Lafon's Watch Escapement

Fig. 7.

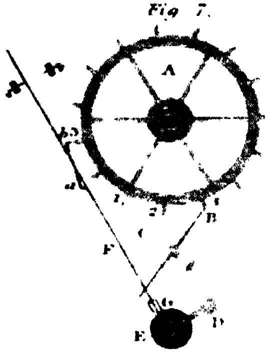


Fig. 5

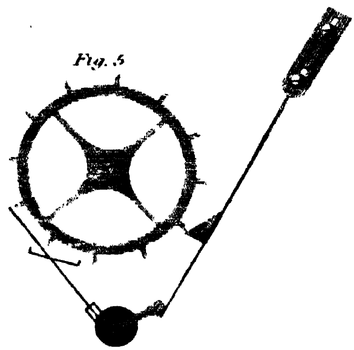


Fig. 3

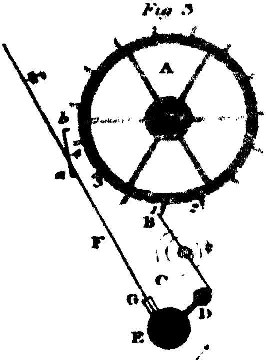


Fig. 4

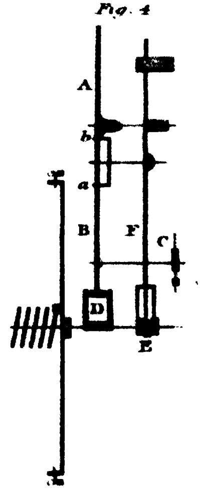
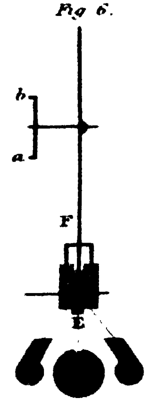


Fig. 6.



F Hilliard

Published by Henry Fisher Caxton London. 1822

respects exactly the same, avoiding the friction of the pivots of the lever-pallet. This method the Inventor prefers for a piece to be kept in one place, as a clock; but the disadvantage from the weight of the spring, in different positions, is obvious.

The locking may be on any two teeth of the wheel, as may be found most convenient.

Detached Escapement for a Watch.

It is generally admitted by those acquainted with the subject, that the longer the vibration of a balance is, the better it will keep time; and in this property the present invention is remarkable.

Figs. 11 and 12, plate LXI, represent the principal parts of this escapement.

Fig. 11, AB, the pillar-plate; as also ABEF, fig. 11, which is a section of the frame, without pillars or potence; C, the cock, screwed to the potence-plate at D; G, the balance, the lower point of which runs in the plate (but perhaps a potence will be more convenient for it in a pocket-watch;) H, the regulating spring, pinned fast in the stud at I; O, the friction-wheel; N, its arbor, the higher pivot of which runs in the collet the balance is riveted to, and the lower in a collet screwed fast on the balance-arbor at P: so when the balance turns round, the friction-wheel is taken along with it.

M, the intermittent lever-wheel; L, its arbor; R, its pinion, in the rim of which wheel are put an equal number of pins on each side. The pins on one side of the wheel are put exactly at the middle distance of those on the other side.

T, the intermittent lever, screwed fast to K, its arbor. QQ, are its banking-screws.

This lever is made of one solid piece of steel; that end of it next the wheel is cut open, wide enough to receive the rim, without touching either side of it, as far as the pallets or inclined planes are; at the end of which it is cut wider, to admit the pins of the wheel. (See fig. 12, a section of it as under L.)

The distance from the centre of the balance to the extreme part of the lever, or end of the pallets, is divided, in a right

line into ten equal parts, and the pivot-hole of the friction-wheel is made at the first tenth division from the centre of the balance. There are thirteen semi-diameters of the friction-wheel from its centre to the end of the pallets.

When the balance is at rest, then the centre of the balance, the centre of the friction-wheel, and the centre of the lever, will be all in one right line.—See fig. 11.

The lever is divided into three equal parts. The distance from the end of the pallets to the centre of motion of the lever, one part; and from the centre of motion to the centre of the friction-wheel, when the balance is at rest, two parts; so that, whatever the velocity may be at the end of the pallets when in motion, that part of the lever, or the forked part of it, which is opposite the centre of motion of the friction-wheel, will be twice as much.

SS represents a superficial view of the pallets. The pallet below the pillar-plate is taken off from the other, otherwise the place of action could not be seen in the drawing.

In fig. 11, we have a view of the lever before the machine is wound up; a pin is half way down the pallet; but when the pin impels the pallet, the lever moves and gives motion to the balance, and the pin is disengaged from the pallet at the angle: that instant a pin, on the opposite side of the wheel, falls upon a circular part of the end of the other pallet, or upon that part where it and the lever are entirely at rest, until the balance makes its return, and the friction-wheel comes into the forked end of the lever. Then the friction-wheel impels the lever, while the balance runs over the space of about twenty degrees, in which time the pin is disengaged, from a place of rest to a place of action, where it impels the lever, while the balance runs over the space of about 100 degrees. Then the pin drops off at the end of the pallets as before, and the balance is entirely left at liberty; at which time its velocity is so great, and its motion so easy, that it turns upon its pivots once round and two hundred and forty degrees every vibration.

It is to be observed that, in the ends of the fork, one part is turned up and the other down, in order that they may not both go through one notch in the balance-arbor; for, by having two different parts cut away, the fork is locked fast in every vibration, and is unlocked only by the friction-wheel, in its return for another vibration.

Notwithstanding the balance makes one turn and two hundred and forty degrees every vibration round its axis, yet

when the balance is at rest, and the same power applied to it which keeps it in motion as above, the balance will only move through the space of about fifteen degrees, which is only one fortieth part of what it keeps up to when in motion. It must be allowed that the less the wheels, or the power, have to do with the balance, the more accurately the time will be shown.

It having been suggested that the above escapement had some resemblance to Mudge's anchor-scape, the Inventor observes, that he had not the least knowledge of Mudge's anchor-scape until he had been in London after having previously sent his own escapement to the Society for the Encouragement of Arts, &c. But having sought for and examined one of Mudge's anchor-scapes, in consequence of the remark made to him, he states, that he found the wheel and pallets to be exactly like those of a common clock with a dead scape, excepting the addition of an arm, whose length is the same from the centre of motion the pallets are of, the use of which is to give motion to the balance against two steps. The teeth of the wheel rest, after every vibration, upon the outside of one, and on the inside of the other pallet, alternately. If that part where the tooth rests be not exactly part of a circle, whose centre is the axis of the pallets, the ballance, while disengaging a tooth from the place where it should rest, will give motion to the wheel, and in so doing will find it more difficult to unlock, than it would be if that place was entirely circular. How these places of rest are to be made entirely so without turning, he cannot tell; and if turned, time will be found necessary in the execution.

But to make the anchor-scape still more complete, the places where the teeth of the wheel rest after every vibration should be equal, and as short as possible with safety, that the balance may loosen them with the least power; but if the places of rest be equal, (as they should be,) the balance will pass over more degrees in disengaging a tooth on the inside of the pallet, than it would do in loosening the other one on the outside.

In the new escapement represented in the plate, the places of rest are equal, and at an equal distance from the centre of motion, which cannot be the case with the anchor-scape, and both turned with ease at the same time: so that the balance will pass over an equal number of degrees, in disengaging a pin from a place of rest to a place of action, on each pallet alternately.

Prior's detached escapement for a watch.

The centre of motion of the lever in the new escapement, is at one-third of its length: so, whatever the velocity of the pallets may be, the forked end of it is twice as much, and will follow the balance through one-third more space than the anchor-scape can do, and by that means will cause the balance to turn further; and when the balance vibrates further, all kinds of external motion do not affect the vibrations, so much as if the balance vibrated less.

The same may be said of the force from the main-spring, which is communicated through a train of wheels and pinions, up to the balance, which force will not be entirely equal, though executed by the best workmen. But the vibrations of the balance will be entirely more uniform, though the impulses given to it through a train of wheels, &c. be unequal, than they would be by the same power or impulses, if the balance vibrated less.

The objections which may be made by those who do not understand it, is the increase of friction upon the balance-pivots; but that will be done away, when the superior advantages are considered in their proper light. And as the balance is that part of the watch which regulates the whole machine for time-keeping, it is necessary that its motion should be disturbed the least possible, both in receiving the impulses, and disengaging that part which gives it motion: this was the reason for introducing the friction-wheel, which goes into the fork of the lever at every vibration, disengages a pin from a place of rest, to where it acts upon the pallet, with as much more ease than it would have done (if the same diameter had been fixed,) as the diameter of a pivot of the friction-wheel is contained in the diameter of the wheel, which may be twenty or nearly thirty times; this, and the length of its vibrations, will add greatly to the perfection of its time-keeping.

If the wheel which is going to be cut by an engine, be not put exactly in the centre of the circle upon which the divisions are put, though the divisions be mathematically true, the wheel will be far from bein so. Apply such an one to the anchor-scape, and it incloses as many errors as there are teeth between the pallets. Apply the same erroneous divisions to the new escapement, and the errors will be four or five times less than in the anchor-scape.

Description of a Nautical Watch.

As the dial, and mode of giving motion to the balance, are the only things in which this watch differs from others, a description of the other parts will be unnecessary.

Fig. 1, plate LXI, shows the position of the great wheel, and two centre pinions; 80 the wheel, 10 and 10 the two pinions.

Fig. 2, the dial, which has two circles for the hours and minutes, one for the seconds, and one for the day of the month, tide, or any other purpose.

Figs. 3 and 4, a method of giving motion to the balance without friction. It can be done with any escapement; the plate represents a horizontal one though neither the common wheel or cylinder. The same letters refer to figs. 3 and 4.

A is the wheel. BB the two edges of the supposed cylinder, on which the teeth of the wheel act, in the common way. C, an arm or lever, fastened on one end of the cylinder, with the end turned up, and passing through a hole, cut through the frame-plate D. There is a small hole in the end of the lever, which receives the pendulum or balance-spring, at the distance of about one turn from its outward end, where it is made fast by a pin. The inward end of the spring is fastened to a collet on the arbor of the balance, in the common way, and the outward end to a stud in the plate; so that, by giving motion to the lever, the outward turn of the spring receives the same motion, which runs through every turn of it to the centre, and there, being fastened to the balance, gives it motion also; and, though the motion of the lever is not one-sixth of a circle, the motion of the balance will be more than one whole turn, as it receives the impulse entirely from the action or elasticity of the pendulum or balance-spring, in which there is no friction; and the balance-arbor not having any kind of pallet to be acted on, by any wheel of the watch, has no friction any where but on its own pivots; so that, if the holes are jewelled, a small movement, with a weak main-spring, will give a very heavy balance one turn and a half motion. The watch may be regulated by applying a curb to the outward turn of the spring in the usual way.

The advantages this mode of giving motion to the balance has over all others, are,

First, that it receives the impulse without friction.

Secondly, that as the wheel has no connection with the balance-arbor, bankings of any kind are not necessary; for, if the balance should turn twice, or more, round, it cannot produce any bad effect; neither can giving the spring a set, by any extraordinary motion, ever put the watch out of beat.

Thirdly, the bad effects rising in other watches, from being placed in different positions, or carried with different sides up, (which causes the weight of the balance to bring the pallet and the wheel that acts on it nearer together, or farther apart, and consequently produces a greater or less impulse,) are entirely done away, as the wheel has not the least connexion with the balance, or its arbor.

The dial is particularly constructed for convenience, as it has two distinct circles for hours and minutes, with indexes to each; either of which may be moved, or set to any particular time, without affecting the other. So that, if one is set to the time of the place sailed from, and not altered during the voyage, and the other set to the time of the place of every observation, the difference of longitude will be seen at one view, by allowing one degree for every four minutes. For example, suppose five hours difference between London and Philadelphia, and the watch set to the time of Philadelphia, and brought to London, the indexes will stand as in the plate, those on the left hand showing the time of Philadelphia, and those on the right hand that of London.

An index for showing the time of the tide, may also be placed under that which shows the hour on the right hand side, or (as before-mentioned) on the lowermost small circle; which will point upwards at high-water; downwards at low-water, to the right at half-ebb, and to the left at half-flood. And notwithstanding the complicated appearance of the plan, if it is examined, it will be found so simple, as not in the least to clog the going of the watch, or subject it to any inconvenience.

Method of equalizing the long and short Arcs of Vibration in Timekeepers.

The equalization of the time of the different arcs of vibrations of the balance of a timekeeper, having given arise to much discussion, three methods of effecting the object are shown in plate LXI.

The first method is by a straight spring placed edgeways across the diameter of the impellent pallet *a*, figs. 6 and 7, and screwed at the end opposite to the direction of the wheel, on its approach towards the centre of this pallet; at the other extremity of this spring is a flat face, or curved surface, to receive the approaching tooth of the escape-wheel, which gives the impulse: this spring acts between two pins placed in the pallet near its end. By reducing this spring to a certain degree of strength, so that it may yield a little to the force of the wheel in giving the impulse, the different vibrations will be performed in the same time; but the proper degree of strength can only be determined by repeated trials. This method possesses besides, this farther advantage, that the acting surfaces are not so liable to be injured by the drop of the wheel upon the spring, as upon a solid surface, nor the vibrations of the balance so much disturbed by the impulse.

The second method is by a straight spring *b c*, figs. 5 and 8, screwed to the under part of the cock, placed edgeways and diametrically over the cylindrical spring, and having a piece cut out to clear the arbor of the balance. This straight spring is at one extremity fastened to the end of the pendulum-spring, and, at the other extremity, its elasticity is reduced, so as to yield a little before the pendulum-spring operates; on the opposite side of the cock, to that where the spring is screwed, is fixed a stud *d*, projecting downward, and having a slit to admit the small piece at the end of the spring *b*; on each side of this slit is an adjusting screw *e e*, the points of which face each other, and are placed so that the spring may move equally between them from its point of rest. The action of the spring between the adjusting screws, requires to be somewhat less than the angle of escapement. Let the balance be made to vibrate, so that the straight spring may move up to the adjusting screws upon each side, and no farther, being weaker than the pendulum-spring, its exertion will be less; hence, the time of the vibrations will be

prolonged, but as they increase, the exertion of the pendulum-spring will commence and progressively accelerate them, and this acceleration will always be in proportion as the exertion of the pendulum-spring is to the action of the straight spring between the two adjusting screws. Thus it will always counteract the accelerating effect of the escape-wheel in the small arcs of vibration, so that the whole of them shall be performed in the same time.

The third method is, by connecting a piece of short spring wire to the pendulum-spring, by a small piece *f*, figs. 9 and 10, with two holes, and pinning the two springs together about half a turn from the stud of the pendulum-spring, and clamping the other end of the short spring at its natural point of rest to a sliding piece *g*, which projects out from the pendulum-spring stud. By this manner of fastening, both springs will act together, and each will retain its natural point of rest; but by moving the sliding-piece, which clamps the end of the short spring, and placing the springs a little on the strain, in opposition to each other's action, the point of rest of both springs will be destroyed. Thus, by producing this counteracting force of the two springs at the lowest point of vibration, the accelerating effect of the escape-wheel upon the balance in the small arcs of vibration, will be corrected, and the whole of them will vibrate in equal time.

A Watch Escapement.

In this escapement the balance acts without friction, and the movement in itself is very simple; the impulse is given without jarring; the inequality of power through the train, has no perceptible effect on the balance; and no additional weight, however great, can produce more than a regular and gentle increase of impetus on the balance. The balance is kept in action by an impelling power without any blow whatever; all other escapements that have fallen within the Inventor's notice, have kept up the vibration by a direct blow virtually on the balance itself; which must certainly be considered as a great disadvantage; for a blow upon any thing of the nature of a spring, produces a shock that can by no means be conducive to the steady motion which is so essentially necessary.

Plate LXII, fig. 1, represents the escapement without the rest of the train; *a a*, are the two plates of the frame between which the train runs; *b* is the last or balance wheel of it, with teeth nearly similar to that of the balance wheel of an eight-day clock, moving with the flat face of the tooth forward against the pallet *c* of an upright spindle *d*; *e* is a locking spring nearly similar to a detached one, having no extra spring to pass to and fro with.

Above the pallet *c*, is a very small one *f*, for the purpose of unlocking the wheel, which is better shown in fig. 2. At the lower part of the spindle *d*, is a hair-spring *g*, so pinned as to bear the pannel *f* against the locking spring with sufficient power, so that of its own accord it frees the wheel, and lays the pin *h*, which comes through the plate, gently up to the stop, consequently the tooth falls upon the pallet *c*, but so close home to the centre of the spindle, that it has no power to pass it of its own accord. The pin *h* referred to, is fixed to the top extremity of the pallet *c*, and rises perpendicularly through the plate *a* some way above the surface.

The balance *i* is fixed on the centre of its spindle, principally on account of equalizing the weight, besides which, it is most convenient to be so. It is supported between the plate *a*, and the cock *k*, precisely over the spindle *d*; consequently, the action of each is in the same arch, and the connection is between the pin *h* of the pallet, and the pin *l* of the balance, (a pin fixed in the balance at the same distance from its centre, as the pin *h* is from the centre of the spindle *d*, and sufficiently long to touch the pin *h* sideways,) there is therefore no friction between them.

The immediate course of vibration is from the spring *g*; the balance-spring is so placed, that the pin *l* of the balance stands near the pin *h* of the pallet. It is to be remembered, that the tooth of the wheel rests on the pallet during the vibration of the balance, so that when the balance is put in motion, the pin *l* comes in contact with the pin *h*, which stands perpendicularly almost imperceptibly fine, and carries it back; as soon as moved, the tooth of the wheel gives it an extra assistance of about one-fifth of a circle, passes, and lays the next tooth on the lock; on the return of the balance, the spring *g* applies all its power in urging the balance forward till it comes to the stop, the balance then maintains its motion, and the small pallet *f*, having unlocked the wheel, the tooth falls again on the great pallet *c*, and waits the return of the balance.

The balance carrying the piece *h* back, forms a most admirable banking, without any extra apparatus; banking is generally done by some kind of stop on the hair-spring, which must have an irregular effect; the further the pin is carried back, the stronger the spring operates against it, and from the extent to which the piece may be forced back, there is play for nearly two whole circles of vibration, without any possibility of upsetting.

Fig. 2 represents the axis *d* shown separately, in order that the arm and pin *h*, and little pallet *f*, may be seen more distinctly.

Fig. 3 shows the balance wheel *b*, and the method of locking and unlocking.

Thomas Ramsay, of Islington, near London, having attended the Committee for the Encouragement of Arts, &c. upon the above escapement, thought it but justice to the Inventor to state particularly its merits. He observes, that in viewing mechanical improvements, we should not confine our ideas to their present properties, but should consider what improvements the principle will admit of; and as the principles of the escapement now described, and that of Mudge's, which obtained a bounty from government, are much the same, he compares the one with the other.

The impulse given to the balance without friction, is exactly the same as Mudge's, the remontoire is bent up by the maintaining power in a similar way to that of Mudge's, but from the form of the pallet, which is a plain surface, it is not so perfect. Mudge's, from the form of the pallet, bends the remontoire always to the same place, the other is bent higher or lower, according to the force of the maintaining power; but by forming the pallet like Mudge's, it would render them alike in that respect. The only other objection is the spring detent that detains the wheel, when it drops from the pallet of the remontoire; it is the same as that of a detached escapement, consequently exposed to the whole force of the maintaining power. To compensate for these objections, the arc of vibration is not limited like Mudge's, which is of great importance; and having only one remontoire, it is more simple. It is therefore superior to Mudge's in having only one remontoire; and being unlimited in the arc of vibration it is superior to the detached escapement in giving the impulse without friction.

Detached Escapement, for a Timekeeper, to ascertain the Longitude at Sea.

The object of this improvement is to reduce friction, and this the Inventor thinks he has accomplished to the amount of one-half over the contrivances in ordinary use.

The good performance of timekeepers essentially depends on the regular and uniform vibrations of the balance, which likewise depend on two particular parts of the machine, viz. that which is called the escapement, or the parts immediately connected with the balance to give it motion; and a proper compensation part to regulate itself in different temperatures; which two are the only parts now worth attention; and although it must be acknowledged, that much has of late been done for the improvement of timekeepers, yet it will scarcely be denied, that they are susceptible of still further improvement.

An escapement is composed of two distinct parts of action: first, that which the wheel locks, or rests upon, while the balance is in motion; and, secondly, that which gives the impulse to the balance after it is unlocked; and those which have the least friction, are undoubtedly the best.

The contrivance of locking the wheel on a spring, if properly made, is perhaps as perfect as human invention can produce: but the mode of giving motion to the balance is not entitled to the same approbation; for when we compare the manner in which the balance of a watch is kept in motion, with that of the pendulum of a clock, we must give the preference to the latter. The formor, moving on opposite centres, as soon as they come in contact, oppose each other, till they come into a straight line, and in leaving each other occasion considerable friction up the side of the tooth, which action, not according with the motion of the balance, greatly retards its progress.

The manner in which the pendulum of a clock is kept in motion is very different; for as soon as the wheel is unlocked, it receives the impulse from what is called a crutch, which being suspended on the same parallel of suspension, describes exactly the same circle, and consequently there cannot be the smallest friction whatever. After numerous attempts to produce the same principle in watches as in clocks, the Inventor found that he could not give the impulse from its

own centre, without introducing other pieces which would counteract the good effect derived from the introduction of this principle; he therefore determined to make the nearest possible approach to it, without employing more pieces than are used in the common construction.

In order to do this, he made a horizontal contrate wheel, and cut teeth on the uppermost rim of it; a piece of brass was introduced inside of it, just free of its bottom, on which was placed, half way between the extremities and centre of the wheel, the axis of the balance, on which was put a round piece of steel with a notch in it, called the impulse-pallet, and nearly half the size of the wheel's diameter. After the wheel is unlocked in the usual way, with the spring, the pallet receives a tooth on the point of the notch, which forces it round in a circular direction nearly corresponding with its own; consequently, there cannot be so much friction, as the teeth do not take above half the usual depth into the impulse-pallet, in which case, jewelling will be quite unnecessary; the machines must last longer, and as good performance depends on the uniform motion of the balance, there is not a doubt, but, if justice is done in executing the other parts of this escapement, and a proper compensation for heat and cold is made to form a part of it, the performance will be found excellent.

Fig. 4, plate LXII, is a perspective view of this escapement.

A, the circular frame of the machinery.

B, the pendulum-spring.

C, the balance.

D, the axis.

E, the cock in which the upper pivot of the axis runs.

F, the impelling pallet, on the axis of which is a small unlocking pallet.

G, the detent and unlocking spring.

H, the axis of the scape-wheel, supported by a cock below it.

I, the scape-wheel.

K, the cock which supports the lower axis of the balance and scape-wheel.

L, the screw for adjusting the locking of the wheel.

Fig. 5, a bird's eye view.

A, part of the circular frame of the machinery.

C, the balance.

M, the small unlocking pallet, above the impelling pallet F.

G, the detent and unlocking spring.

I, the scape-wheel.

K, the cock which supports the axis of the balance and scape-wheel.

L, the screw and small cock for adjusting the locking of the wheel.

Fig. 6, is a diagram to show the scheme for reducing friction, by bringing the action more concentric with the scape-wheel.

A Noctuary, or Instrument for ascertaining the Hour in the Night, when connected with a common Watch.

A repeating watch, though a very elegant contrivance, has some inconveniences. The expense of the cheapest repeater renders such an instrument uncommon, and the mechanism is in general very liable to be out of order, while in some cases, even the exertion of pushing in the pendant, and the sound of the bell, are circumstances that it would be agreeable to dispense with. A cheap frame, therefore, like the noctuary described below, which will enable a person, by placing in it any common watch, to ascertain the hour simply by the touch, without the least noise or difficulty, is well suited to meet the wishes of those who desire such information.

This noctuary is represented by fig. 7, plate LXII.

AA, is a mahogany board, upon which two others, B and C, are fixed, so as to form a groove between and underneath them, in which the index D, shown separately at fig. 8, descends;—on the opposite side of the board, a flap or door of mahogany is fixed, by two hinges *a a*, and a clasp; between this and the board AA, a cavity is formed to contain the watch, as shown by the dotted circle X; the dial appearing through a circle in the door, a hole is made through the board A, opposite the fusee-square, to receive a key, upon which the small pulley E is fixed, and from which the index D is suspended by a fine thread in the groove above-mentioned. It is plain that as the fusee-square and pulley E revolve, the

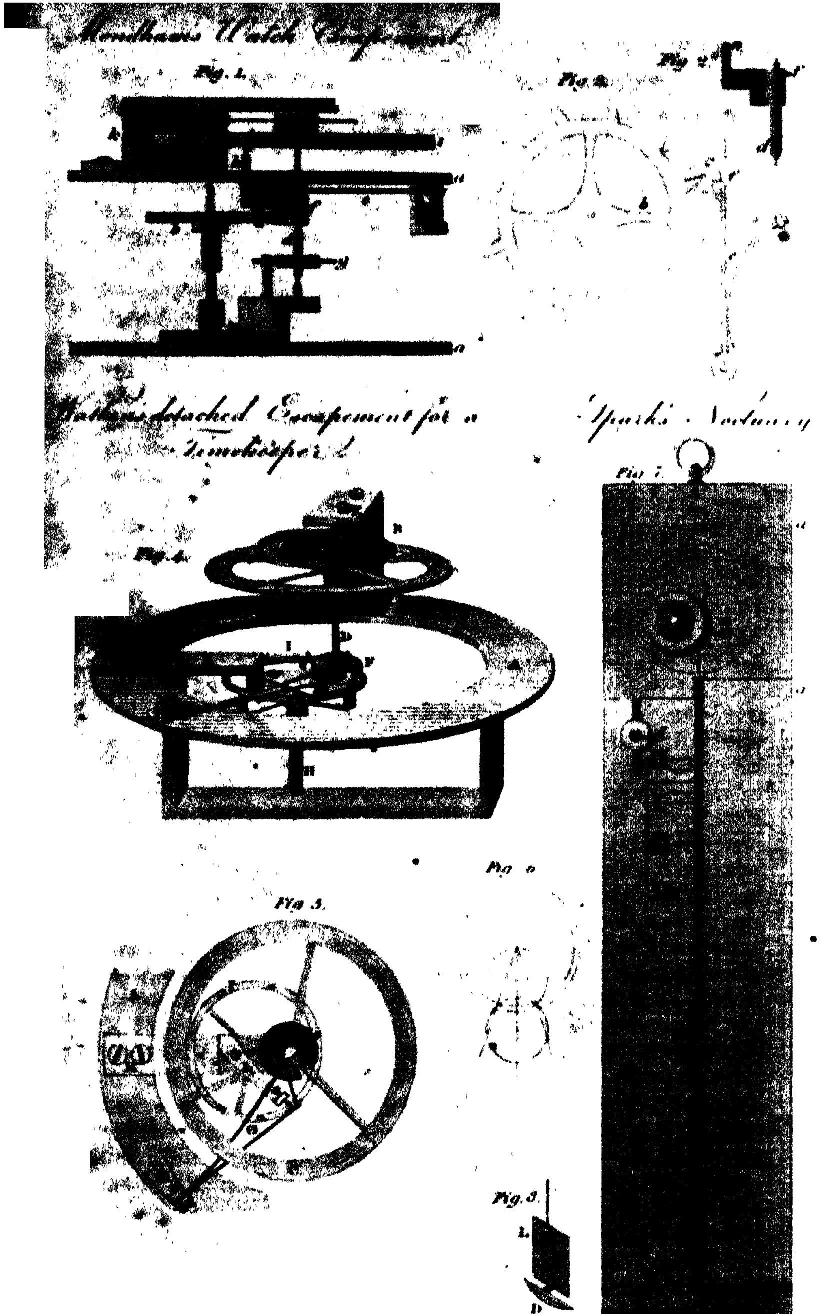
index descends, and points out the hour by coming opposite the several marks, commencing at nine and ending at seven, which are fixed upon the board B; the marks from twelve to seven, are made by pins projecting from the surface, so as to be readily distinguished by the finger; the index, represented in perspective at L, fig. 8, is made very light, that it may not influence the motion of the watch. The watch must be wound up, before it is placed in the frame, and the thread wound upon the pulley E, so much as to suspend the index nearly the height of the hour when it is set; the key is then pushed on the fusee-square, and if the index does not point exactly at the right hour, the scale B can be slided up or down to adjust it; the screws *d d*, which hold it, being fitted in grooves for that purpose; after this setting, the index will point out any succeeding hour, descending a division at each.

F is the ring by which the instrument is suspended; and G is a hole in which the key on the pulley E is placed when the watch is removed, and the instrument out of use.

Escapement for a Marine Timekeeper.

For this invention a patent was taken out, the specification of which is dated August 17, 1796. It is designed both for marine and pocket-timekeepers. It is calculated to communicate to the balance an invariable and equal force, notwithstanding the imperfections of the main-spring, and the train of wheels, by which the motion is generally communicated; and this is effected in a regular and simple manner, by means of an immediate agent or spring, with a new apparatus, placed between the balance-wheel and balance, which is wound up 150 times in a minute, by the common movement; and as, in a train of 9,000 beats per hour, there are 150 beats per minute, just so often will the balance be impelled by the renovating-spring, but this matter will be particularly described hereafter.

Figs. 1 and 2, plate LXIII, represent the principal parts of the movement that are more immediately connected with this new invention; the same letters of reference are put to both, so that, in reading the description, the eye may be directed from the one to the other.



Published by Henry Fisher Caxton London, 1823

AB is the potence-plate, and T the balance; the pivots of whose verge or axis PX are run into the cock C, and potence D; above the balance T is fixed a pendulum-spring S, in the usual way, by pinning the upper end of the spring to a piece screwed upon the balance-cock, and the lower end of it to a piece which is twisted on the axis of the verge, immediately above the balance. Below the balance, and on the axis of the verge, (which is a small solid cylinder,) are placed two small steel collets I and K; these collets turn stiffly on the axis of the verge, so as to be set in any position, and each has a ruby pallet, fixed in the collet, and standing a little way beyond their surfaces. We call I the discharging pallet, and K the impelled one; it is therefore obvious, that if the balance be made to vibrate ever so little, the pendulum-spring S, and pallets I and K, will vibrate to and fro along with it. E is the balance-wheel, of the usual form, which is run just free of the upper surface of the potence-plate; its upper pivot is run into a cock F, screwed on the same side of the potence plate; and its lower pivot into a cock G, screwed on the lower side of the same plate. WV is the axis of the new-invented renovating-spring R, and its apparatus; the axis is a small solid cylinder, and its upper pivot is let into a cock H, screwed on the potence-plate, and its lower pivot V into another cock D, which is screwed on the under side of that plate. This axis is placed directly between the balance-wheel and verge, consequently the axis of the balance, or verge PX, the axis of the renovating-spring WV, and the balance-wheel E, have their centres all placed in the same right line AB.—(See fig. 2.)

On the axis of the renovating-spring, and in the same plane with the balance-wheel E, is stopped the round steel pallet M; it is just so large as to turn round without touching the points of the teeth of the balance-wheel at 1 and 2, (see fig. 2.) There is a notch cut in this round pallet, so that the teeth of the wheel may be at liberty to act into it. The face or notch of the pallet is represented as having moved from a position pointing to the tip of the tooth 2, to 1, by the tooth 1 of the wheel acting into it. On the upper side, and close to this round pallet, is twisted a steel pallet N, in form of a snail; this new contrivance may be called a snail-pallet. There is a small dovetail cut in this pallet, near the centre, into which is fixed a small ruby pallet: it points directly to the face of the notch of the round pallet M, or to the tip of the tooth 1 of the balance-wheel. Above this snail-pallet is

twisted a collet O, (see fig. 1,) to which the lower end of the helical renovating-spring R is pinned, and the upper end is attached to a piece which is screwed upon the cock H, near W. On the same axis with the renovating-spring, but on the lower side of the potence-plate, is twisted the pallet L; it may be called the impelling-pallet, because when the renovating-spring is discharged, it communicates that motion to the balance, by striking upon the pallet K, which is placed upon its arbor. It is necessary to observe, that the renovating-spring with its collet O, the snail N with its small ruby pallet, the round pallet M, and impelling-pallet L, being all attached to the same axis WV, will all move backward and forward together, with the same velocity, and keeping the same distance asunder. In fig. 2, *a* is a detent-spring fastened on the upper side of the potence-plate, by a screw and steady-pin *n*: this spring points directly to the centre of the verge, to which it approaches very near. The breadth and height of it above the surface of the potence-plate is represented at fig. 3, which is equal to the height of the discharging-pallet I, above that plate.

Upon the side of the spring *a*, next the balance-wheel, is fastened a very tender spring *m*, fig. 3, by means of two pins near *a*: this spring projects a little way beyond the end of the other, and is therefore nearer the centre of the verge; there is also fixed, near the end of the stronger spring, a ruby pallet *r*.

The cock *b*, fig. 2, is screwed upon the potence, and the hole at *i* is tapped, to admit the thread of the adjusting-screw *c*, its head being placed towards the centre of the snail; and the ruby *r*, of the detent-spring *a*, is made to bank against the inside head of this adjusting screw, bearing with a small degree of elasticity. This adjusting-screw *c* is purposely put at some distance from its place, and connected by a dotted line, because it would cover the small ruby pallet *r*, and acting face of the snail, and thereby prevent their action from being seen.

When the snail pallet N is brought from the balance-wheel E towards the verge, the renovating-spring is wound up; but when it moves from the position it has in fig. 2, towards the balance-wheel E, it is let down. When the renovating spring is wound up, the inclined or rounded-off part of the snail acts on the inclined part of the back of the ruby pallet *r*, and thereby presses the detent-spring *a*, and ruby pallet, outwards, or from the balance-wheel, until the snail passes over the ruby pallet; when the detent-spring returning to its

former place, the snail is prevented from returning, and therefore the renovating-spring remains suspended in a state of tension. If the discharging pallet I, on the axis of the verge, is moved from its present position to the other side of the detent-spring *a*, it will lift the delicate spring *m* until it pass on the other side of it, but without affecting the detent-spring *a*, which is banked upon the head of the adjusting-screw; but when the discharging-pallet returns to its point of rest, it will carry both springs with it; and when the ruby *r* is lifted beyond the reach of the snail, the renovating-spring will be discharged, and move with considerable velocity towards the balance-wheel.

There is also placed on the other side of the balance-wheel E, another detent-spring *d*, but without any other spring attached to it; nor does the pallet which lifts it ever pass on that side which is opposite to the wheel E: it is screwed on the upper surface of the potence-plate, and points directly to the centre of the axis of the snail, which it almost touches. The height of this detent-spring above the surface of the plate is shown in fig. 4; *s* is a sapphire-pallet, which is set into it, and the tooth 3 of the balance-wheel is represented as resting upon it. *y* is an adjusting-screw, which moves the detent-spring *d* nearer or farther from the verge, so that the teeth of the balance-wheel 1 and 2 may be equally free of the round pallet M.

The balance-wheel E moves in the direction of the arrow Z, and therefore will extend the spring *d*, when locked upon it. *e* is a cock, and *f* an adjusting-screw, which is screwed into the end of the cock *e*, with its head towards the centre of the balance-wheel E, on which the sapphire-pallet *s* banks, in the very same manner that the detent-spring *a* banks upon the adjusting-screw *c*, already described. *g* is a small cock or stud, in which there is an adjusting-screw, to bank the detent-spring *d*, when it is lifted from the balance-wheel outward. Let any force move the balance-wheel in the direction of the arrow Z; then, when the small ruby pallet near the centre of the snail, facing the tip of the tooth 1, comes to strike the detent-spring *d*, the sapphire pallet *s* will be lifted beyond the tooth 3, so that the wheel may escape, but the face of the round pallet will be brought into a position pointing to the tooth 2; at that instant, the balance-wheel will strike on the face of the round pallet, and carry it back again to 1, when the snail will have passed beyond the ruby *r*, and thereby wind up the renovating-spring.

Haley's escapement for a marine timekeeper.

Here it is plain that the force of the train must be sufficient to wind up the renovating-spring, the strength of which may be increased or diminished at pleasure.

Having considered the action of the principal parts of the escapement separately, it now remains to describe the operation of the whole together. When the balance is at rest, and the renovating-spring wound up, the whole will appear ready for action, as in fig. 2; we must also imagine the balance-wheel to turn round in the direction of the dart Z, and that it is pressing against the sapphire *s* of the detent-spring *d*, with a force equal to what remains of the main-spring, after passing through a train of wheels; and we are farther to suppose the force of the balance-wheel, renovating-spring, and weight of balance, adjusted to one another: if, in this situation, the balance and its spring are made to vibrate, so that the dicharging-pallet I, on its axis, passes on the other side of the detent-sprine *a*, by lifting the tender spring along with it until it drops, but, when the discharging pallet returns, it lifts both springs of the detent *a*, the ruby *r* being carried beyond the reach of the snail-pallet, the renovating-spring is discharged, and immediately the impelling-pallet L, fixed on its axis, strikes the pallet K, on the axis of the verge, carrying with it the balance, with its pendulum-spring, until such time as the pallet L has carried the pallet K as far on the other side of the line AB, which joins the centres, and is just ready to quit it. During this time, the round pallet snail, and other apparatus belonging to the renovating-spring, are perfectly detached from the balance-wheel; but, presently after the two pallets K and L have left one another, the small ruby pallet, near the centre of the snail, has advanced to discharge the detent-spring *d*, and the acting face or notch of the round pallet will point to the tooth 2; but the sapphire pallet *s*, of the detent-spring *d*, being lifted beyond the reach of the tooth 3, the tooth 2 of the balance-wheel drops on the face of the round pallet, returns it back to its former position, and winds up the renovating-spring. In the mean time the balance, from the impulse it has received, continues to vibrate above a semi-circle, more or less at pleasure, from the point of rest. On returning back, it will pass the point of rest, and move the tender spring, without meeting with any obstacle in the way; for the impelling-pallet L was, at the same moment of renovating the spring, shifted back to its proper place. The balance now returns back, discharges the renovating-spring, which impels the balance, and is again renovated by the train; and thus the motion is continued.

Although we have made choice of a train of 9,000 beats per hour, it is left to the direction of the artist to fix upon a quicker or slower train. The timekeeper may be made to go 30 hours, 50 hours, or a week, without winding. The renovating-spring may be a spiral, having all its coils in the same plane, or in the surface of a cone, or cylinder, and may be made of steel, gold, platina, &c. and the principle of renovating may be applied several ways. Instead of the detents acting as springs, they may be made to move on pivots, and may be placed either above the potence-plate or below it.

Application of a Crank as an Escapement for Clocks.

The advantages of this escapement, are, first, simplicity of construction, consequently cheapness. It can easily be adopted by the manufacturers of the common wooden Dutch clocks, as the whole escapement can be formed of a few pieces of wire bent till properly adjusted, without even the necessity for the adjusting screws II, fig. 5, plate LXIII. Hence the benefits of this invention may extend to the poorer part of the public.

2ndly. Total silence when going; clocks being excluded by many persons to whom, and from many places where useful, merely on account of their noise : this advantage may be of some consequence.

3rdly. Keeping good time, arising from this principle that the crank always impels the pendulum in the same manner; that is, as it passes through the semi-circle under its centre, always one way; and as it passes through the semicircle over its centre, always the other way; and it recurs to the same situation it set out from, after these two impulses, which being easily made equal by means of the adjusting screws, notwithstanding the small difference in length of the levers acted upon, all the succeeding impulses must also correspond with these, and be equal and regular, as far as regards the escapement itself. In other escapements, if any irregularity exists with respect to one or more of the teeth or pins in the scape-wheel, or the pallets or inclined pallets they act against, the impulses given to the pendulum cannot be equal and regular; and the higher the number of the scape-wheel, the greater the probability of this imperfection.

Goodrich's mode of using a crank as an escapement.

4thly. Durability and great certainty of continuance. This escapement does not require oil, which, as it becomes clammy and thick by the dust, is the frequent and well-known cause of the stopping of others; it does not wear itself untrue and out of order. The friction of the collets upon the crank must be very small, as the acting surface is small, and as the intensity of the impulse upon the pendulum is in proportion less in this, as it acts upon a longer lever than in others; also at the time that the chief force is exerted, as the crank passes over and under its centre, there is very little turning of the collets upon it; hence this escapement, properly made, will last as long as the train itself without being out of order.

Fig. 5, plate LXIII, is a front view of the crank-escapement.

Fig. 6, a side view of the same.

The same letters of reference are put to the corresponding parts in each figure.

AAAA, the back plate of a clock.

B, the crank fixed on the end of.

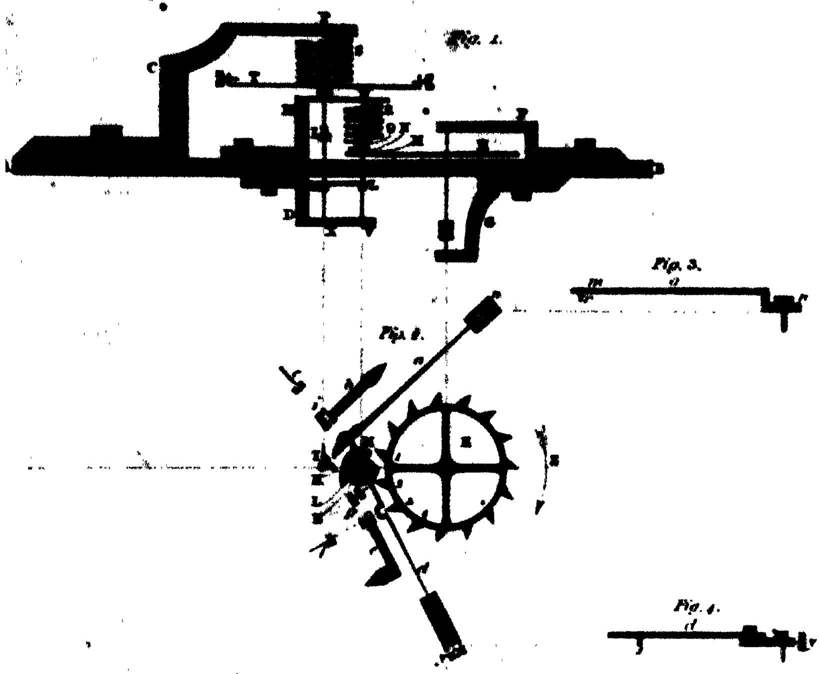
C, the arbor of the last pinion of the train.

DD, two small wire chains, composed of two links only, attached to the crank B by means of two collets, with plenty of liberty upon it. These chains are fastened to EE, two small springs screwed to FFF, which is a bar that goes across, and is fastened in the middle to GG, the crutch, with which HH, the pendulum is suspended in the common way.

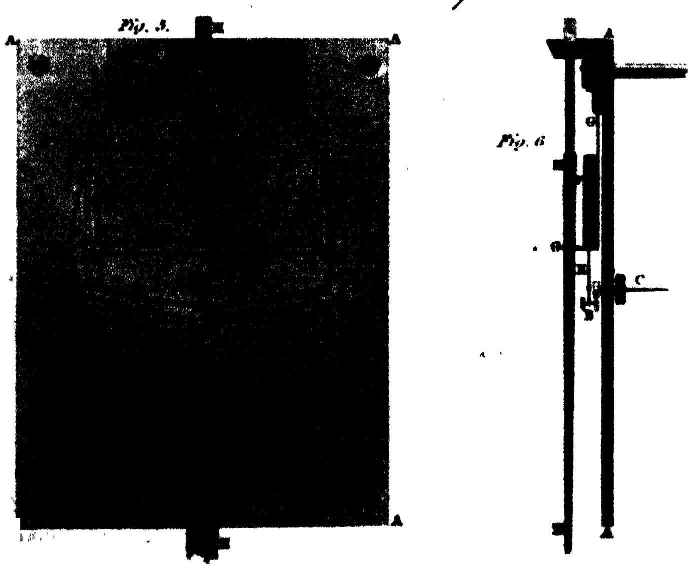
II, are two screws going through the bar F, the ends of which being made to act against the springs EE, serve to adjust them to a proper distance and degree of strength, and by that means easily to put the pendulum in proper beat.

In fig. 5, the pendulum is partly represented by dotted lines, in order to show the crank, &c.

Haley's Escapement for a Marine Timekeeper.



Goodrich's Crank Escapement.



Escapement for a Clock.

This escapement will answer for a pendulum of any length, and the friction is so small that it requires no oil; when the tooth of the wheel sufficiently touches the impelling-spring, it is properly scaped, and the friction is very insignificant.

It is necessary that the detent-spring, the impelling-spring, and the pendulum, should all spring from one right line or centre; and the impelling-spring to be so much stronger than the detent-spring as will always be sufficient to unlock the wheel.

The machine being wound up, and the pendulum put in motion towards the left side, the impelling-spring unlocks the wheel, when a tooth falls against the pallet, where it remains until the pendulum returns; then moving the impelling-spring, and the wheel being free, the maintaining power causes it to advance while it escapes one tooth off the end of the pallet or spring, and another tooth is locked against the detent-spring, as before, while the pendulum returns, and the impelling-spring again unlocks the detent. As the impelling-spring moves towards the left, the resistance it meets with by the elasticity of the detent-spring in unlocking, is returned to it, so that there is no more power lost than what was caused by the pressure of the wheel against the detent-spring; by which means it is freed from the loss of the maintaining power, which is evident in other detached escapements, by the pendulum or crutch, &c. touching a spring or lifting a lever, to regain the position for unlocking the wheel.

The screw in the pendulum rod is to adjust the machine when fixed up.

Fig. 1, plate LXIV, is a side view of this escapement, and fig. 2, a back view of it, supposed to be taken behind the clock.

a Represents the axis of the swing-wheel, or last wheel of the train of the clock; *b d* is the swing-wheel fixed upon it, having 30 serrated teeth; it is turned round in the direction from *b* to *d* by the maintaining power of the clock.

g Is a spring-detent, which locks against one of the teeth of the swing-wheel, and thus prevents its running down by the action of the maintaining power.

h Is another spring-detent, which is called the impelling-spring; when left at liberty, it unlocks the former by pushing against the end of the small arch *e*, fig. 2, fastened to the

about one-third more than is necessary to raise the inclined plane, so as to allow for an increase of friction, which may take place in the wheel-work. There must be a cross piece fixed to the pendulum, which must come into contact with two pins that are fixed in the inclined planes of the pallets, so as to unlock one in each vibration of the pendulum. Suppose the pendulum to be put into motion, and to have unlocked the inclined plane on the right; the wheel moves forward, and raises the inclined plane on the left, at which time the pendulum receives a momentum from the spring pallet on the right, and after performing its excursion to the left, receives a momentum as on the right, and so on alternately. The advantage of this escapement over that above described, is, that it avoids the friction of the verge and detent pivots; and, during a part of the vibration, the pendulum is disengaged, so that it is a free pendulum.

The first method above proposed for lessening the friction in escapements of pendulum clocks, is represented by fig. 3, plate LXIV.

A, the swing-wheel.

BC, the two pallets.

DD, the detents on which the two pallets B and C are fixed.

E, one of the *remontoire* springs on the left side; another, similar to this, is on the right side of the frame, but is not shown in the plate.

F, the verge.

G, the arms fixed on the verge, which act on the pins H I of the pallets.

K, the pendulum, fixed in the usual way on the verge.

In the second escapement, which is represented by fig. 4, *a*, is the free pendulum, without a verge.

b, The swing-wheel, on the outside of the back plate.

c d, The pallets, formed like a pair of tongs.

e, A spring which keeps them extended against the points of the adjusting screws.

f g, The points of the pallets.

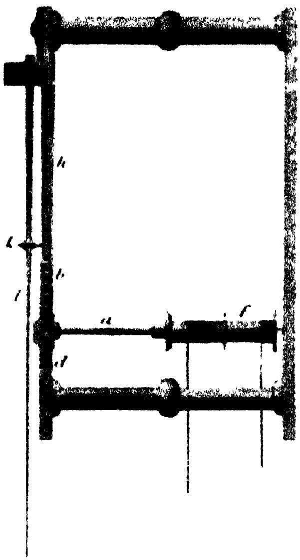
h i, The adjusting screws of the pallets.

k, The cross piece fixed to the pendulum, which piece, as the pendulum moves backwards and forwards, comes in contact with the two pins on the points of the pallets *f g*, and relieves the wheel.

The pendulum is supposed to be in motion, and the dotted lines show those parts of the machine which are hidden by others.

Prior's detached Escapement for a Clock.

Fig. 1.



Massey's Escapements for Pendulum Clocks.

Fig. 4.

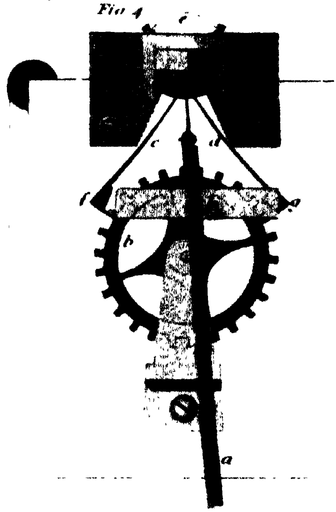


Fig. 2.

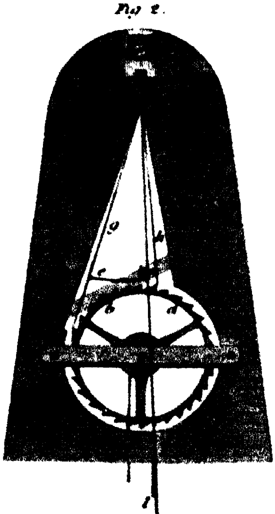
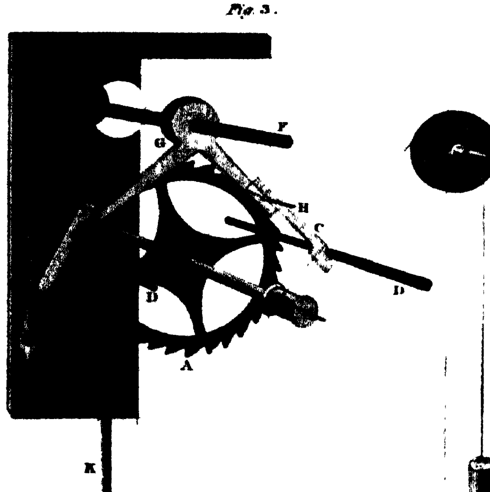


Fig. 3.



Published by Henry Fisher Caxton London 1823

Simple striking Part of an Eight-day Clock.

The advantages of this striking part will be understood from the following account:

First, its principle consists in a wheel and fly, with six turns of a spiral line, cut upon the wheel, for the purpose of counting the hours. The pins below this spiral elevate the hammer, and those above are for the use of the detent. This single wheel serves the purpose of count-wheel, pin-wheel, detent-wheel, and fly-wheel, and has six revolutions in striking the twelve hours.

Let it be supposed that a train of wheels and pinions, of the usual sort, is made without error, and that the wheels and pinions turn each other without shake or play. Allowing this, which every mechanic knowns to be more than can be accomplished, this new striking part will be found six times superior to others, in striking the hours, 1, 2, 5, 7, 10, 11; twelve times in striking, 4, 6, and 8; and eighteen times in striking 3, 9, and 12.

The Inventor, to prove these assertions, in the model he sent to the Society for the Encouragement of Arts, &c. purposely made some defects. In striking 2, the imperfection was made equal to the space of three teeth of the wheel; and in striking 3, the imperfection was made equal to nine or ten teeth; and yet both these hours were struck correctly.

The flies of clocks in general turn round about sixty times for every stroke of the hammer, but this turns round only three times for the same purpose; and supposing the pivots to be of equal diameters, the influence of oil on them would be as the number of revolutions in each.

In fig. 1, plate LXV, A is the large wheel, on the face of which are sunk or cut the six turns of a spiral.

B, the single worm screw, which acts on the above wheel, and moves the fly C.

D, the spiral work of the wheel A. The black spots show the grooves into which the detents drop, on striking the hour.

E, the groove into which the locking piece F drops, when it strikes one, and from which place it proceeds to the outward parts of the spiral in the progressive hours, being thrown out by a lifting piece H, at each hour; the upper detent G being pumped off with the locking F, from the pins in the wheel A.

In striking the hour of *twelve*, the locking piece, having arrived at the outer spiral at H, rises up an inclined plane, and drops by its own weight to the inner circle, in which the hour one is to be struck, and proceeds on in a progressive motion through the different hours, till it comes again to twelve.

I, the hammer-work made in the common way, which is worked by thirteen pins on the face of the spiral.

Fig. 2, K, the thirteen pins on the face of the spiral, which work the hammer-work.

L, the outer pins, which lock the detent.

M, the pump spring to the detent.*

Improved striking Part of an Eight-day Clock.

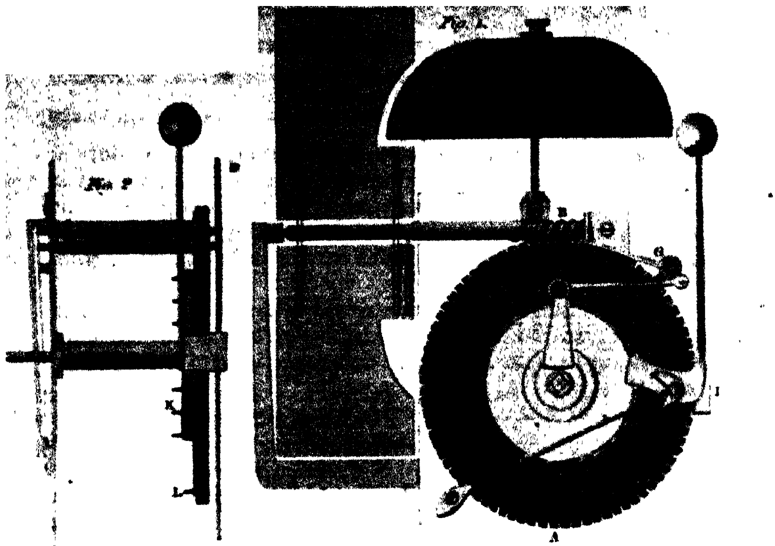
The Inventor of this striking part, having for several years had in contemplation a method of striking a clock, at certain regular intervals, with a view to facilitate the making of celestial observations, ascertaining the velocity of sound, &c. at length succeeded to his wishes. His striking movement contains less work than that of the common sort, and may be made by an ordinary workman with less expense and trouble; the weight required is also considerably less. The stroke is regulated by a pendulum instead of a fly.

The machine (which is shown at figs. 3 and 4, plate LXV.) consists of a toothed wheel A, one pinion B, a pin-wheel C, pallets DD, pendulum E, and locking detent G. The hammer-work F is as usual, and strikes on the bell at H. The weight hangs to the cord I.

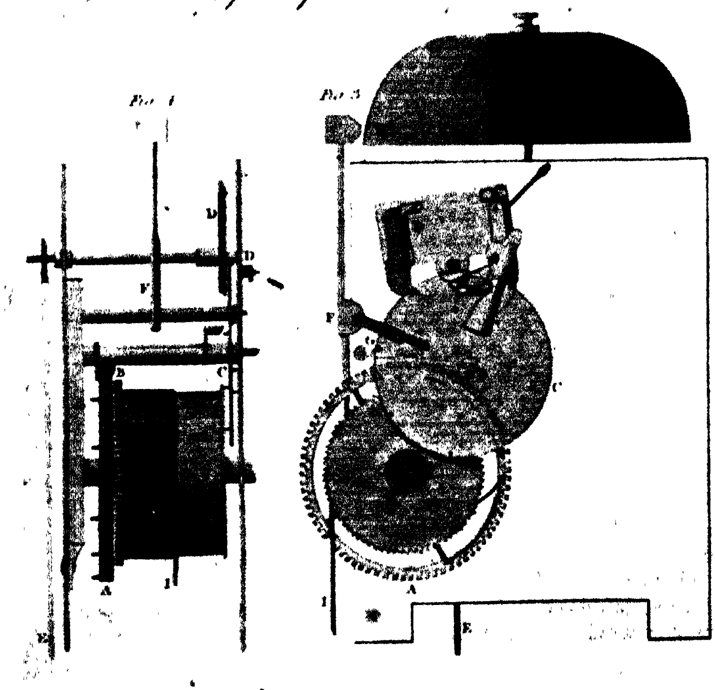
A front and side view of the machinery are given, and the same letters denote the same parts in each view.

The main wheel A, with 78 teeth, is to act in a pinion of eight leaves, B.

The pin-wheel C, should be large, so that the pins on which the pallets D, and the locking detent G act, may be flung as far from the centre as possible, which pins may be eight or sixteen in number. If eight, the pendulum E should be about nine inches long, and it will vibrate twice betwixt each blow of the hammer; but if sixteen pins are put in the wheel, the pendulum must be about three inches long, and



Massey's striking part of a Clock regulated by a Pendulum



Published by Henry Fisher, Caxton, London 1825.

will make four vibrations between each blow. The pins for drawing the hammer must be eight in number, and be fixed in a circle of about half the diameter of the aforesaid pins. The locking plate is on the main wheel. The stop is against the pins on which the pallets act, and may be discharged by a flirt-piece.

The following remarks are added, to point out the method of striking a clock by the common pendulum, true seconds, without any additional pendulum or pallets for the striking part:—

Fix a contrate wheel of 60 teeth on the same arbor with a swing-wheel of 30 teeth. Now suppose a striking part to be made in the common way of making an eight-day clock, so far as the pallet pinion, leaving out the warning and fly pinions; a crank piece must be fixed on the pallet pinion, which must come into contact with the contrate wheel, which is fixed on the swing-wheel arbor. Then suppose the clock to be set a going, and the rack discharged, the pallet pinion will make a revolution on every vibration of the pendulum, by which means a clock will strike seconds as true as a pendulum vibrates.

Compensation Pendulum.

This compensation pendulum is remarkable for its simplicity, and on that account alone, well entitled to notice. In fig. 1, plate LXVI, AB represents the steel rod extending through the whole. C the bob, supported upon the compensating cylinder of zinc D, which surrounds the rod AB, and rests upon the nut E of a screw tapped upon the end of the steel rod, to bring it to exact time; as this expands downwards by heat, the zinc expands upwards the same quantity; so that the bob always remains at the same distance from the point of suspension.

Fig. 2 is a section, to explain more clearly the thickness of the zinc tube D, and the form of the steel rod at *a*, where it passes through the bob, which is of the shape shown at L, that the rod or the bob may not turn round when the nut E is turned to adjust it to time.

The following method is employed to make this compensating pendulum of steel and zinc. Procure a rod of forged

blister-steel 52.7 inches long, .27 diameter; heat it to a white heat, which will open the pores of the steel, and give it the smallest expansive power that steel of that texture is possessed of; when cold, straighten it with a mallet of wood on a wooden block, that no part may be condensed partially, which would be the case if a hammer and anvil were used. Then cast a solid rod of zinc 12.5 inches long, and .68 diameter, with the lowest heat that will fuse it; pour it into a metal mould; this will give it the greatest density, consequently the greatest expansion that zinc is possessed of. Then bore a hole through the centre of it longitudinally, that it may move freely on the steel rod, which has a nut and screw at the bottom end to regulate the clock to time; the bob, as shown in the engraving, rests on the upper end of the cylinder of zinc, and will continue in the same place, whatever may be the expansion or contraction of the bars, if the adjustment be correct.

If platina were used instead of steel, and steel instead of zinc, a pendulum might be made equally good, and more compact; but not at so small an expense.

The above dimensions are to be understood, in the finished state of their diameters and lengths, proper for a seconds pendulum.

The difficulty, or rather impossibility of making a good pendulum, where a compound metal, as brass, is employed, arises from the circumstance that neither brass nor any compound metal can be made uniform, not even for one foot in length; and then, if drawn into wire, the parts acquire a longitudinal grain, which adds to the variation of the expansive powers. To avoid this, zinc has been substituted, with no more certainty of success; for if a pendulum is made in the summer, and the steel pins fill the holes well, and it is exposed to a severe frost, and put to the clock for only a few years, the invisible fissures will become visible in the performance of the best clock, and a visible separation render the pendulum useless.

Compensation Pendulum.

In plate LXVI, fig. 3, *h h i i*, are two flat rods of iron or steel, about half an inch wide, and an eighth of an inch thick. *k k* is a rod of zinc interposed between them, and is nearly a quarter of an inch thick. The corners of the iron rods are bevelled off, that they may meet with less resistance from the air, and it likewise gives them a much lighter appearance. These three rods are kept together by means of three or four screws *l l l l*, which pass through oblong holes in the bars *h h k k*, and screw into the rod *i i*. The rod *h h* is connected to the one *k k* by the screw *m*, which may be called the adjusting screw. This screw is tapped into the rod *h h*, but that part of it which enters the zinc rod *k k*, has the threads turned off, and passes barely through that rod. The rod *i i* has a shoulder at its upper end turned at right angles, and bears on the top of the zinc rod *k k*, and is supported by it. It is necessary to have several holes for the screw *m*, in order to adjust the compensation.—See fig. 4.

Now it is evident, that if any degree of heat or cold be applied to this compound rod, and the one of zinc expands and contracts as much as the two iron ones together, the distance from the point of suspension to the centre of oscillation must remain the same.

In proportioning the length of the rods, the Inventor made use of Smeaton's table of the expansion of metals, in the 48th vol. of the Philosophical Transactions; where he shows, by experiments made with a pyrometer, that the expansion of iron is to that of unhammered zinc, with the same degree of heat, as 151 to 353, and to that of zinc hammered, half an inch per foot, as 151 to 373. This great expanding property of zinc, renders it in theory extremely fit for the purpose of compensation in a pendulum, and it became desirable to know if it would answer in practice, and likewise the exact proportion that was requisite for the intended purpose.

Two regulators were therefore made, the pendulums of which were composed of iron and zinc, as above-described, with this difference, however, that one had a detached escapement of a particular construction; the zinc rod was not hammered, the ball of a lenticular form, and weighed twenty pounds; its arc of vibration nearly five degrees. The other had a simple remontoiring escapement; the zinc rod was hammered

half an inch per foot; the ball of a spherical form, weighed forty-six pounds, and vibrated two degrees and three-quarters.

These regulators were both placed in the same room, and their cases firmly fixed to the wall; the pendulums were suspended from a stout brass cock, screwed to the back of their respective cases. In the inside of each case, and immediately behind the pendulum rod, was hung a thermometer, for the purpose of comparing the degrees of heat. They were adjusted to mean time nearly, by corresponding altitudes of the sun. After being compared together for several days, it was found that the one which had the hammered zinc rod went somewhat faster than the other, when the air of the room was heated by a fire in the grate. Hence it appeared that the difference of expansion of hammered and unhammered zinc was greater than Smeaton had supposed.

But to determine whether the length of the hammered zinc rod was accurately proportioned to that of the iron ones, without waiting the length of time that nature would require to produce a sufficient alteration in the temperature of the air, the following experiment was instituted: A tin tube was made, six feet long, and two inches and a half in diameter at its larger end, whence it gradually tapered to the other, which was only half an inch in diameter. Within the clock-case, and as far from the pendulum as possible, was placed this tube; the smaller end was carried through a hole in the top of the case, and projected a few inches above it. In the lower end of the tube was inserted the nozzle of a lamp, and immediately under it, in the bottom of the case, was a hole of an inch diameter, to supply the lamp with air. By this means the tube would communicate as much heat to the internal air, as to raise the thermometer about thirty-five degrees.

Previous to the lamp being put in the case, both pendulums were caused to vibrate exactly together, and after an interval of twenty-four hours, the one with the hammered zinc rod had gained about one-tenth of a second. The mean height of the thermometer was fifty-three degrees. The lamp was now lighted, and in about four hours every part appeared to be thoroughly heated, and the thermometer arrived at its maximum, which was eighty-eight degrees; at this point it continued with little variation. While the heat was increasing, the motion of the pendulum was accelerated. In about ten hours after having been again made to beat exactly together, the heated pendulum had gained one second; the thermometer

in the other case continuing nearly the same. The lamp was then taken out, and as soon as the parts were cooled, and both thermometers showed the same degree, the beat of the pendulums were adjusted as before; and at the end of twenty-four hours, the pendulum that had been heated kept precisely the same rate as it did before the experiment was made.

By this experiment the zinc rod was evidently too long, and that by a considerable quantity. The pendulum was then taken down to have more holes made for the adjusting screw, and after repeated trials with the lamp and tube, as before, the length of the zinc rod was found to be twenty-two inches,* and consequently the length of the iron ones together $39.2+22=61.2$ inches; or, the expansion and contraction of iron to that of zinc hammered, half an inch per foot, as 151 to 420.

The hammered rod of zinc having been thus tried, similar experiments were made with an unhammered one; in performing which a singular circumstance occurred, viz. when the air in the case was rarefied by means of the lamp and tube, the arc of vibration became about half a degree less than it was before the lamp was applied, which is directly the contrary to what might have been expected. It was afterwards found that the other pendulum was affected in the same way, but in an extremely small degree, which was doubtless owing to the ball being much heavier, and vibrating in a smaller arc. In taking the rate of the clock when the lamp was in the case, the error that would arise by such a diminution of the arc, was computed by theory, and allowed for accordingly; but as it was uncertain whether the unlocking of the swing-wheel might not form a decrease of velocity in the pendulum, and have a greater tendency to retard its motion, it was thought that the experiment would be rendered more accurate if the maintaining power was increased until the arc of vibration should be the same. After several trials, the length of the unhammered rod of zinc was found to be twenty-nine inches, which agrees pretty nearly with Smeaton's experiments, that is, in regard to the relative expansion of iron and unhammered zinc.

The zinc rod of the pendulum from which the representation in the plate was taken, was hammered three quarters of an inch per foot; and by making experiments with it as above

* Subsequent experiments, carefully conducted, evinced that twenty-three inches was the most proper length.

stated, the length of it was found to be twenty-two inches, which is exactly the same length as the one that was hammered half an inch per foot, so that it seems nothing is gained after hammering it to a certain degree; but probably no rule can be laid down to enable us to judge of the degree of expansion that will take place with a determinate increase of heat, from the quantity that is extended by the hammer; much depends on the degree of curvature and polish of the stake and hammer, and probably on the heating of the rod at the time; for it is necessary to make it a little hotter than boiling water, otherwise it will crack in hammering.

In all these experiments it is to be understood that the ball of the pendulum was suspended by its centre; but if the ball be made to rest on its lower edge, the expansion and contraction of it must be taken into consideration.

It has been the opinion of some mechanists that zinc is an unfit substance for a compensation pendulum, because of its softness, and that after being heated or cooled to a considerable degree, it does not return to its original dimensions. If these causes of objection were just, they would apply more or less to all other metals; but experiments made by the Inventor of the pendulum proposed in this article, do not warrant them. He observed, however, a circumstance which is not a little curious. When he first used any zinc pendulum, he never could bring the clock to keep the same rate two days together; it was continually retarded, whether the lamp was used or not; had he not before observed a similar effect on a lever pendulum that was made of brass and steel, he should have ascribed the cause wholly to the softness of the zinc rod; but by constantly comparing the daily rate of the defective pendulum with one that had been going a longer time, he found this retarding property gradually to wear off, and in less than a month the pendulum became quite settled to the rate that it afterwards kept. By subsequent experiments with the lamp, he found that all his pendulums kept precisely the same rate, both during the time they were heated (provided they were properly adjusted) and afterwards as they had done before. He conjectures the cause of the retardation to be, that the points of contact of the different pieces, which compose the pendulum, are more closely connected after a little time than they are at first; that is, the points of contact, by the weight of the ball, yield to each other in a small degree, until they get a broader bearing.

The advantages of this new pendulum, as stated by the Inventor, are,

1st. That from its simplicity, it will never fail to have the desired effect.

2ndly. That no extraordinary care is requisite in executing it.

3rdly. That the compensation may be increased or diminished with the greatest ease, without stopping the clock more than a minute, by making fast one of the screws that keep the rods together whilst the adjusting screw is removing, taking care to release it again afterwards.

4thly. That it can be manufactured at less expense than any other compensation pendulum hitherto made known.

A Compensation Pendulum.

To point out distinctly such parts of this pendulum as are claimed as improvements, it may be observed, that expansion bars have been used by many persons in various ways. The spring balls which correct the expansion bars, have likewise been used. The improvements consist in the application of the two expansion bars, and the springs that remove the weight of the pendulum ball from the expansion bars; by which the bars may be reduced to the size of the pendulum rod, and exposed equally to the heat and cold; likewise, in having the compensation near the ball, and only one pendulum rod.

The compensation of this pendulum operates upon the same principle as the compensation balance used in the modern chronometers, namely, the flexure of a bar compounded of two metals, brass and steel for instance, of different powers of expansion, under any certain degrees of heat. Fig. 5, plate LXVI, represents a front view of the pendulum, and fig. 6, an edge view of a part of it.* In fig. 5, A is the suspending spring, and B the ball, C the steel rod of the pendulum, and E the screw-nut, by which it is adjusted to time; the compensation part consists of two compound bars, F and G, the former of which is connected by means of a brass socket *d*, which is screwed to the lower end of the rod C; the

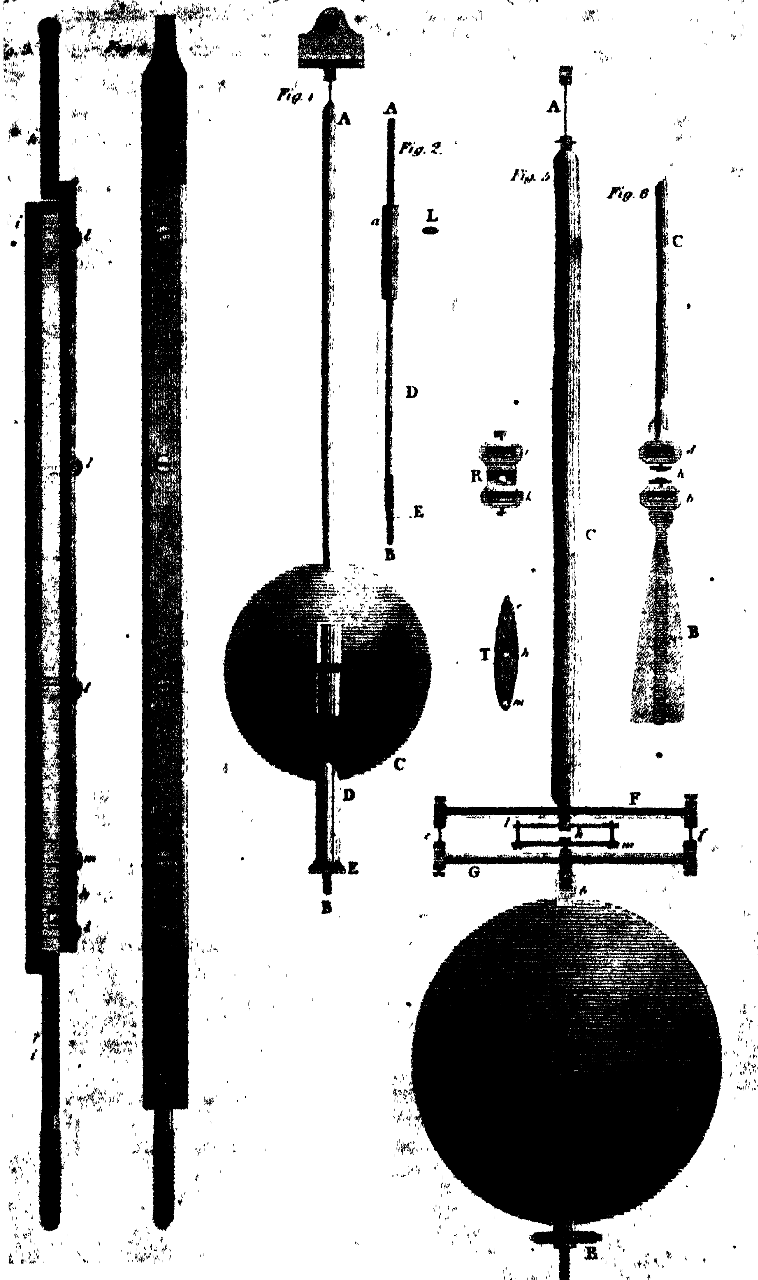
bar G, is connected by a similar socket *b*, with a short steel rod which passes through the pendulum ball B, and has the nut E tapped upon it; the two bars, F and G, are connected together at both ends, by two pairs of sockets *e f*, one of which is shown detached at R; it consists of two pieces of brass, *i k*, each having a mortise through it, to receive the end of one of the compound bars, and a small screw to fasten them in; the two pairs of brass sockets are connected by a small piece of watch-spring, having a hole drilled in the middle of it. The principal sockets, *d* and *b*, have each a small screw *h* tapped into them, which fixes them upon their respective bars FG: the heads of these screws pass through two small springs, *l m*, one of which is shown separately at T, and the ends of these springs are united by two small screws, *l m*. The intent of these springs is to take off the weight of the ball, and allow the compensation springs freedom to act.

The action of this compensation pendulum is this, on being heated, the rod C expands, and would let the ball B down farther from the point of suspension, but for the compensation which counteracts this tendency; the bars FG, are made, as before-mentioned, of brass and steel riveted together, the upper side of F, and the lower side of G, are steel, as shown by the darker shade, and the adjacent sides of both bars are brass. Now it is the property of a bar thus compounded of brass and steel, to warp or become convex on the brass side, when heated in consequence of the greater degree of expansibility of that metal; therefore, in the pendulum before us, when the rod C elongates by heat, the two bars, FG, at the same time both become convex withinside, and as the ends are confined a certain distance asunder, by the connecting pieces *e f*, the two sockets *d b* approach each other a certain quantity, tending to elevate the ball: and this quantity is adjusted to be equal to the descent which would have been occasioned by the lengthening of the rod C.

The adjustment for the quantity of the compensation is made by experiment, altering the quantity of the compensation, by sliding the two connecting pieces, *e f*, nearer to the central rod, which diminishes the quantity of compensation; and by removing them nearer to, or farther from the centre, it may be regulated at pleasure.

In addition to the opinions delivered by many of the trade, to the Committee of the Society for the Encouragement of Arts, &c. in favour of the above pendulum, Thomas Ramsay,

Ward's ompensation Pendulum. Reid's Compensation Pendulum. Ritchie's Compensation Pendulum.



of Islington, for the general information of the society, delivered in the following useful observations, to point out more fully its properties:

The gridiron pendulum has much friction, is difficult to adjust, and from the great weight of the rods, the centre of oscillation is much above the centre of gravity.

Ellicot's pendulum, in its improved state, is objectionable on account of its friction; Ward's pendulum has likewise friction; Read's pendulum has friction, and depends upon a doubtful metal, viz. zinc.

Doughty's pendulum has the whole weight of the ball and two pendulum rods, resting on the extreme ends of a long compound bar, placed at the upper end of the pendulum, which cannot be adjusted without altering the length of the pendulum; and from the weight of the rods and bar, the centre of oscillation is considerably above the centre of gravity. Grimaldé applied a single compound bar to the lower end of a pendulum, but it is now laid aside.

Ritchie's pendulum has only one steel rod, with two short compound bars of brass and steel, placed near the ball, at right angles to the pendulum rod; the bars being parallel, admit of perfect adjustments without altering the rate of the clock. A simple contrivance is introduced between the compound bars, which takes off the weight of the ball, and leave them at liberty to contract or expand, free of every encumbrance.

The compound bars may be reduced to the size of the pendulum rod, and will be equally affected by heat and cold. It is free from friction. It has some advantages over the mercurial pendulum, by being portable, and not liable to be deranged. It may be applied to the smallest table-clock, or the largest turret. It is likely to be of great public utility, and can be afforded for less than half the expense of the most approved pendulums.

A short Pendulum to vibrate Seconds.

AA, fig. 1, plate LXVII, represents two weights, which may be made of any form or size. B is a bar which connects them, and which is suspended by two springs CC, the upper ends of which pass through the bar D, in the same manner as the pendulums of common clocks are suspended. The bar D is screwed to the back plate of the clock, and the springs CC are moved nearer together, or farther apart, by the screw E, which has one end cut with a right hand, and the other with a left hand screw.

This pendulum can be applied to a clock of any size, and with any escapement; it receives a horizontal motion from the clock, by applying the fork on the pallet-arbor to one of the springs CC, or to a wire fixed in the bar B for that purpose; and is prevented from having any other motion than a horizontal circular one, by the small steel pin in the spring F; which spring has one end fastened to the bottom of the clock-case, and the pin at the other end goes into a conic hole in the bottom of the bar B.

To regulate the clock so as to make it go faster, the springs CC are moved farther apart: and to make it go slower, the contrary, or nearer together; and if the screw E, and that part of the bar B which is between the springs CC, are of brass, and the rest of iron, the properties of the compound or gridiron pendulum will result.

The advantages of this pendulum over all such as vibrate twice or more in a second are,

First, that it has but one half as much friction in the scapement.

Secondly, but one half the resistance from the air.

Thirdly, the same clock will keep in motion one of four times the weight.

And fourthly, its great convenience, being applicable to clocks, or timepieces, of any size or height, from three inches and upwards; so that any small portable clock or timepiece, on this construction, will both beat and show the seconds as distinctly as one of the largest size.

Improved striking Part for an Eight-day Clock.

The striking part of this clock is so far simplified, that the whole train of wheels used in common clocks, together with the barrel and weight, are entirely superseded.

The power necessary for raising the hammer is obtained from the pendulum.

AAAA, fig. 2, plate LXVII, represents the front side of the frame.

B, a cock in which rests the pivot of the pallet-arbor.

C, a brass arm, firmly fixed on the same.

D, the gathering pallet; and E, a thin plate of brass, both riveted on the same collet, which turns on a small stud fixed in the arm C; this brass plate has two notches in it, at *a b*, in which acts a slender spring F, fastened to the collet of the arm C, by a small screw, and serves to keep the gathering pallet in its proper position.

G, the cock of the hammer-tail.

H, the hammer-tail, which acts also as a hook in the teeth of the rack.

I, a brass arm, or rather a lever, which lies behind the minute-wheel N, and is fixed with the hammer-tail to the hammer-bar by means of a pin.

K, the flirt; M, the rack; N, the minute-wheel.

O, the hour-wheel. The bridge and snail are the same as in a common clock.

The operation of this work is as follows: a pin is fixed in the back of the minute-wheel N, and as it revolves, raises the lever I, by which the hammer-tail H is lifted out of the rack; the rack is then at liberty to fall; the lever I, by bearing against the pin, returns gradually, and prevents the hammer from striking the bell.

Before the pin has quitted the lever I, another pin in the front side of the same wheel begins to lift the flirt; when raised to a sufficient height, it is let go by the pin, and falls on the gathering pallet D, which forces it into the rack. It is prevented from rising out of the rack by the spring F having got into the notch *b* of the brass plate E; the pallet immediately acts on the rack; for, as the arm C moves from left to right, it lays hold of a tooth, and carries it along with it by means of the *vis inertiæ* of the pendulum, at the same time the hammer-tail is raised by another tooth of the rack, and on quitting it the ham-

mer strikes the bell. When the arm C returns with the gathering pallet from right to left, the rack is prevented from returning with it by the tooth resting against the end of the hammer-tail, the pallet is then carried over another tooth, and at the next vibration moves the rack and hammer-tail as before; thus they continue to act alternately on each other till the rack is up, and the clock makes one single stroke regularly at every other vibration.

In order to disengage the gathering pallet, there is a pin fixed in the rack at c, and as soon as the last tooth of the rack has got past the hammer-tail, the shoulder of the brass-plate E, which is riveted to the pallet, strikes against the pin c, and lifts it out of the rack, the spring F jumps into the notch *a*, and prevents it from returning; thus it remains detached, and the pendulum continues to vibrate without any obstruction. The ball of the pendulum weighs about eight pounds thirteen ounces, and the weight twenty-four pounds.

The objections which may perhaps be made to this clock is, that the striking part disturbs the isochronism of the pendulum; but whoever will take the trouble to try it against another pendulum of the same length, both before and after it has struck, will find no sensible alteration, and even if that were the case, the irregularities would be periodical, and return to themselves every twelve hours.

The advantages of this clock over a common clock, may be stated as follows :—

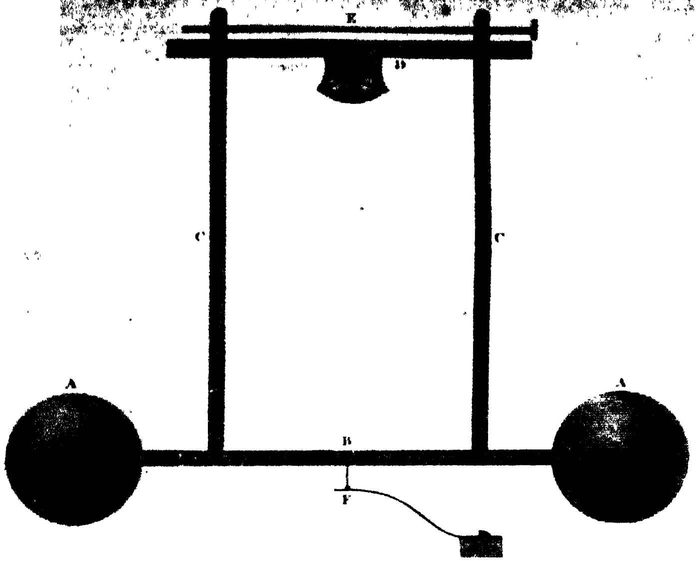
1st. That it is not attended with that disagreeable roaring which is frequently made by the wheels and pinions of others, and particularly by the fly pivots, when in want of oil.

2nd. That the interval between the strokes is uniformly the same: the case is very different in other clocks, for as they get foul they always strike slower, and more so still when the weather is cold.

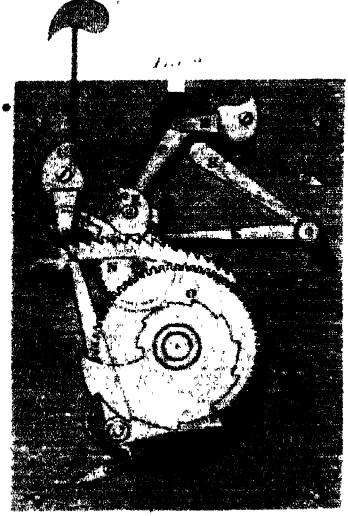
3rd. That in consequence of its simplicity, it is not liable to be out of repair.

4th. That it can be manufactured at considerably less expense.

[illegible] Short Pendulum to vibrate Seconds.



[illegible]



An improved Remontoire Escapement for Pendulum Clocks.

This escapement is calculated to give an exact and equal impulse to the pendulum without friction. This impulse cannot be at all affected by any irregularities or variations arising by the clogging of oil and increasing of friction from the train, except during the very small part of the vibration in which the pendulum is removing the spring detents from off the points of the teeth of the escape-wheel, the effect of which can never be discovered in the rate by any variation the oil on the pivots and the increase of friction can ever produce, as long as the wheels are able to wind up the renovating spring, which will be nearly as long as they can move at all, as the renovating spring has not either to be wound up quick, or to be pushed beyond any catch or spring to keep it in its proper situation; nor can there ever be any increase of friction in winding up the renovating spring, it being formed as nearly in a right line as possible; consequently the work will go almost without cleaning, and will never require any oil, still keeping the pendulum vibrating up to the same arc, which of course cannot avoid keeping time, if properly regulated for expansion. This must be a very desirable attainment for regulators, in astronomical and other observations, where the greatest accuracy is required, as regulators, once properly regulated, ought to go as long as can possibly be contrived, without making the slightest alteration necessary. If all the parts of friction in the whole escapement be added together, they will not amount to the breadth of the acting part of the pallet of a common vertical watch verge, which every watch-maker knows to act without oil.

The complexity of remontoire escapements has always prevented their use, as no good performance, except for a short time, can be produced from them, from their liability to want frequent oiling or cleaning; even Massey's, rewarded by the Society of Arts, Manufactures, and Commerce, which is one of the simplest and best, must frequently want oiling, or it will stop, owing to the friction of the teeth of the escape-wheel in sliding up the inclined planes of the renovating springs to wind them up.

The swing wheel A, figs. 1 and 3, plate LXVIII, has 30 teeth cut in its periphery, and is constantly urged forwards by the

maintaining power, which in the model represented in the engraving, is supplied by a small weight X, figs. 2 and 3; CD are two spring detents catching the teeth of the wheel alternately; these are, at the proper intervals, unlocked by the parts marked 2 and 3, fig. 1, upon the pendulum rod H, intercepting small pins *a b*, fig. 2, projecting from the detents, as it vibrates towards the one or the other: E is the renovating or remontoire spring, fixed to the same stud F as the detents; it is wound up by the highest tooth of the wheel, as seen in fig. 1, (its position when unwound being shown by the dotted line.) This being the case, suppose a tooth of the wheel is caught by the detent D, which prevents the wheel from moving any further, and keeps the renovating spring from escaping off the point of the tooth; in this position the pendulum is quite detached from the wheel; now, if the pendulum be caused to vibrate towards G, the part of it marked 2 comes against the pin *b*, fig. 2, projecting from the renovating spring E, and pushes this spring from the point of the wheel's tooth; on vibrating a little farther, it removes the detent D, which detained the wheel, by the part 3 striking the pin (*a*, fig. 2) which projects from the detent; the maintaining power of the clock causes the wheel (thus unlocked) to advance, until detained by a tooth resting upon the end of the detent C, on the opposite side, by this means the renovating spring will be clear of the tooth of the wheel as it returns with the pendulum, and gives it an impulse, by its pin *b* pressing against the part 2 of the pendulum, until the spring comes to the position shown by dotted line, in which position it is unwound, and rests against a pin fixed in the cross-bar I of the plate: the pendulum continues vibrating towards I, nearly to the extent of its vibration, when the part 1 meets the pin in the detent C, and removes it from the wheel and unlocks it; the maintaining power carries it forward, pushing the renovating spring E before it, until another tooth is caught by the detent D, which detains the wheel in the position first described, the renovating spring being wound up ready to give another impulse to the pendulum.

The pin *b*, fig. 2, is not fixed to the renovating spring itself, but is part of a piece of brass, which is screwed fast to the renovating spring, and is made very slender near the screw which fastens it; this permits the end of the renovating spring to give way, if by the weight being taken off the clock, or any other accident, the escape-wheel should be moved backwards, so as to catch on the detents improperly.

The following observations are necessary to be attended to in this escapement:

1st. That the renovating and detent springs must spring from one centre, and as similarly as possible.

2nd. That the force applied to the train must be so much more than what will wind up the renovating spring, as will overcome the influence of oil and friction on the pivots of the machine.

3d. That the renovating spring when unwound, must rest against the point of the tooth of the wheel, which will be an advantage, as it thereby takes as much force off the tooth of the wheel resting against the detent spring, as is equal to the pressure of the renovating spring E, against the face of the tooth of the wheel.

4th. The detent springs must be made as slender and light as possible, though whatever force they take from the pendulum, by their elasticity in removing them to unlock the wheel, so much force they return to the pendulum in following it, to where it removed them from, therefore action and re-action will be equal in contrary directions.

5th. That it is unnecessary for the pendulum to remove the detent or renovating springs, much further than is necessary to free the teeth of the wheel, as it will always vibrate up to the same arc; in table-clocks it ought to remove them further, so that it can go when not placed exactly level, or what is generally termed, out of the beat.

A Larum applicable to Pocket Watches.

The Inventor, in constructing this machine, endeavoured to render it as simple as possible, consistently with the properties he required it to possess. By the assistance of a pocket-watch, of any size, or any number of turns of the fusee, whichever way it is wound up, it will cause the larum to let go at any time required, without hurting the going of the watch.

The main-spring of this machine is wound up in such a manner as to admit of its acting with considerably more power than where thicker pivots are used. The discovery of the method of stopping the main-spring, when wound up, without a fusee, may prove useful on other occasions. To show

with what ease a watch will turn the larum-screw, the following experiment was made:

When the machine was wound up, and the lever put upon the screw, the axis of the screw was turned while one of the pins which has a communication with the key when the watch is put to the larum, was parallel to the horizon; its distance from the centre of motion was one-eighth and three-fourths of an inch. A slender thread was hung upon the pin, with ten grains troy weight tied to it, which moved the screw.

This larum may be set a week before hand, if the watch would go so long, by increasing the number of the threads of the screw.

When a watch is made to wind up the contrary way, it is necessary only to take out the pin in the axis of the detent, and turn the lever the other side up, and then it will drop off at the other end of the screw to disengage the larum.

By winding up a watch designed to be used with the machine, at two periods just twenty-four hours distant, it is easy to ascertain how many hours are contained in each revolution of the fusee; the most common are four, five, or six hours for each turn. The common index is divided into 120, which does for three concentric circles. That next the centre is for a watch fusee of four hours a turn, the next five, and the last six. While the band of the larum passes over one of the divisions, it will be equal to two minutes to the four hours circle, two and a half to the five hours, and three minutes to the six hours circle, all shown by the same hand.

Before a watch is put to the larum, it must be fitted with a key that will not drop off when the watch is turned with the keyhole downward; than hang up the watch by the pendant to the holder, which may be turned while the key-end on the watch is opposite to the axis of the screw, and the face of the watch parallel to the plate. Then turn the sliding pieces any way, as may suit the watch in that situation, and screw it fast.

Supposing the watch to be four hours in making a turn of the fusee, turn back the hand of the larum while one of the pins touches the pin in the watch-key, and if the hand is not at the top, turn it back till it is. If the larum is intended to go off in four hours, lift the lever into the first turn of the screw; if in five hours, turn back the larum-hand one hour; if in six hours, two back; if in seven hours, three back; and if in eight hours, do not turn it back, but put the lever into the second turn of the screw; and so for the rest.

Fig. 4, plate LXIII shows a bird's eye view of the machine.

Prior's larum for pocket watches.

A, shows the position of the watch on the larum.

B, the spiral cylinder, fixed on the axis, and moved by a pin across a key placed on the fuzee-square of the watch.

C, the acting lever, one end of which lies upon the spiral, the other end is moveable upon an arbor D.

E, shows a notch cut in the arbor D. This notch is cut more than half through the arbor, in a situation opposite to a pin at F, in the middle of the rim of the larum contrate-wheel G. When the lever C falls off the cylindrical spiral B, the notch E is moved to a situation so as to allow the pin F to pass through the notch which discharges the larum-hammer H, which works by pallets in the contrate-wheel G in the usual manner.

O, the barrel which contains the spring, the inner hand of which is connected with the same axis as the contrate-wheel.

K, the finger piece which winds up the spring.

b b b, The three sliding pieces which hold the watch.

c c, Two projecting pins, carried round by the pin *d*, which is fixed across the key fitted to the fusee.

Fig. 5, shows that side of the machine on which the watch is fixed.

a, The sliding piece on which the pendant of the watch is hung.

b b b, The three sliding pieces which serve to adjust the watch, and hold it in such a position that the fusee-square may be in a line with the axis of the spiral cylinder B, shown in fig. 4.

I, is a ratchet-wheel, on the centre of which is a button or finger piece K, to wind up the larum-spring.

L, the click which works in the teeth of the ratchet-wheel.

H, the lower part of the arm of the hammer.

M, the bell, within which the hammer strikes.

N, the cock in which the pivot of the axis of the pallet acts, and to which the hammer is connected.

Fig. 6 shows a section of the ratchet-wheel and spring-barrel, which are screwed together, and move at the same time, but are kept in their place by two pieces *e e*, which fit a groove in the barrel.

K, the button or finger-piece.

I, the ratchet-wheel.

P, the box for the spring.

R, the cap which covers the spring-box.

V, the axis on which the main-spring is wound.

Fig. 7, R, the cap, under which is the spring. On the

edge of this cap, at S, is an indent to retain the spring when wound up.

T, a lever, with a hook at its end. At the end of this lever, on a line with the hook, is a small piece of steel, which goes through a hole in a box, and presses upon the main-spring; so that when the main-spring is wound up on the axis V, the hook is at liberty to fall into the way of the indent S, and is there stopped. Under this lever T is a small spring, which presses it against the main-spring within the barrel.

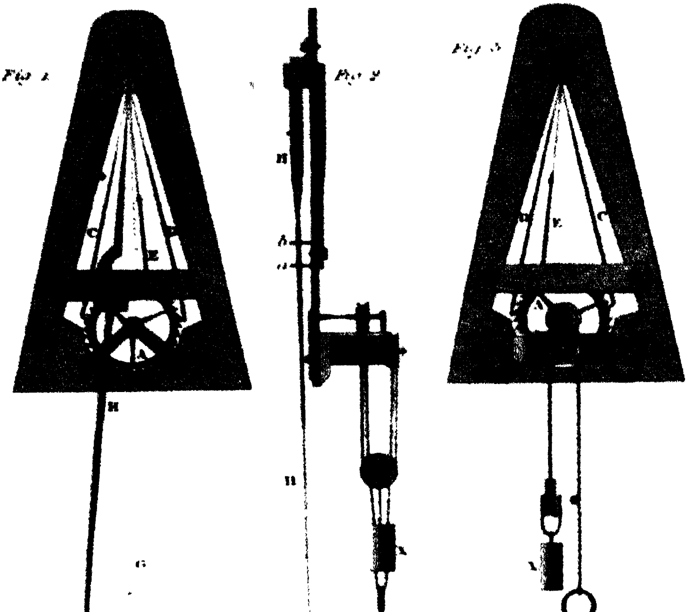
Fig. 8, shows the index of the larum; the outside circle of which is divided into 120 parts, which index serves for three concentric circles; that next the centre is for a watch-fusee of four hours a turn, the next five, and the last six, as before explained.

Detached Escapement for Clocks and Watches without Springs.

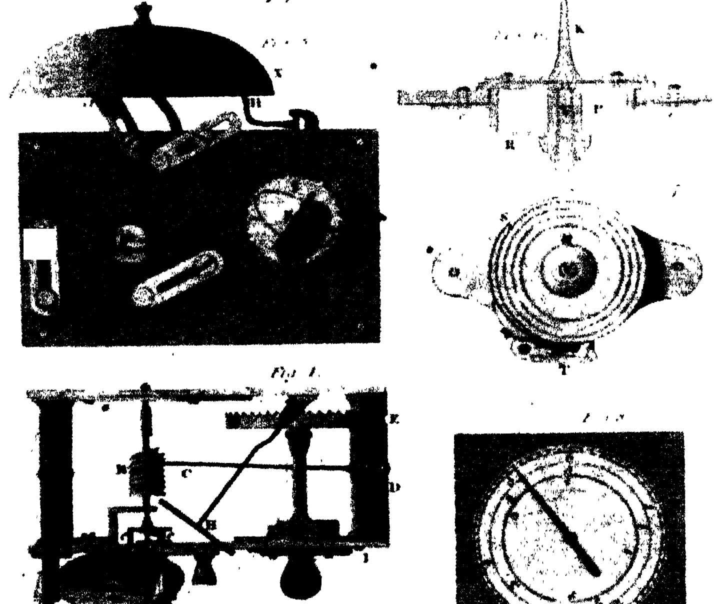
This invention is an improvement of the escapement of a chronometer made by Larcum Kendal for the Board of Longitude. The object of the improvement was to get rid of the friction upon the cylindrical part of the verge, and permit the balance to vibrate clear from the escapement-wheels; this being accomplished, the balance vibrated two turns and back safe, against the back part of the fork belonging to the detent; and by the pallet upon the verge, the detent is driven from one wheel to the other with the greatest ease. The action of the levers upon the upper part of the fork is a preventive, so that the detent cannot get clear from the place where the verge left it; this detent being counterpoised, and without springs, the work is particularly strong. The wheels are, when the balance is at rest, unlocked; so that the balance cannot move without receiving motion.

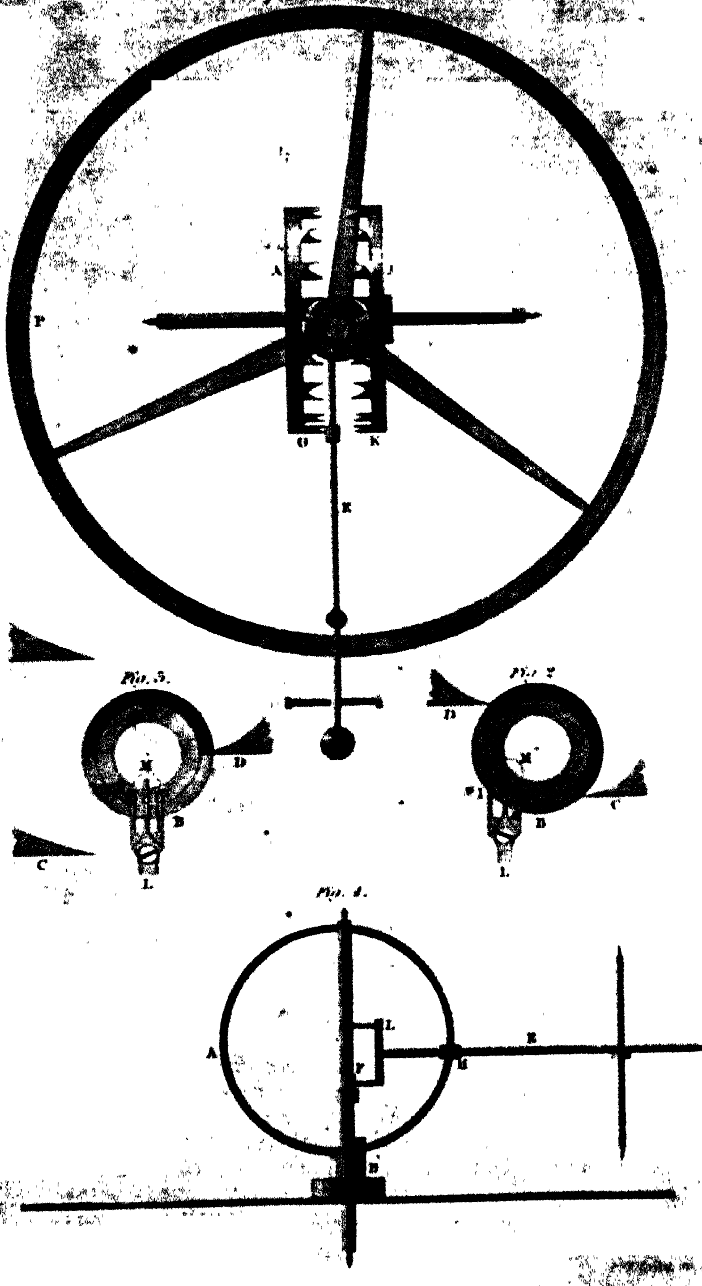
This escapement does not require oil, any more than the pallets of common verge watches; whereas inclined plane escapements always require oil. The balance, situated between the two wheels, will always receive the same impulse, in whatever position the watch may be placed; the want of which property is the great defect of detached escapements.

Prior's improved remontoire Escapement



Prior's Larum applicable to Clocks & Watches





Published by Henry Fisher, Caxton, London. [illegible]

AA, fig. 1, plate LXIX, two crown wheels fixed upon the same axis, passing near to the staff of the verge, supported by two counter potences upon the upper plate.

F, the balance, supported by the cock and potence.

E, the detent that locks the wheels, alternately supported by a cock upon the upper plate, with two banking screws.

Figs. 2 and 3, are pallets upon the verge, and the teeth of the wheels drawn larger, in order to be more distinct.

Fig. 2, B, a semi-circular pallet, which the tooth C is just quitting, and the tooth D is going to take: the wheels are locked by the pallet H, upon the detent E, (see fig. 1.) till the pin F, (fig. 2.) upon the verge, takes it into the fork, and relieves the tooth G (fig. 1) from the pallet, and carries it to I, (fig 2.) and the pin F will have carried the detent E, with the pallet H, and locked the tooth of the wheel at K.

Fig. 3, is the pallet, &c at the point of rest, the piece L, which is screwed upon the detent E, fig 1, is to prevent its being moved at any time but when the pin F takes it, the end of it just clears the verge, and when the pin F takes into the fork, it passes through the notch M, but is not intended to touch it. This piece is left out in fig. 1.

Fig. 4 is another view of the escapement, serving to show the several parts in a different position.

The same letters refer to the same parts in all the figures.

A detached Striking Part for a Clock.

This striking part originated with the Inventor, in consequence of his being engaged to make a clock to go eight days, strike the quarters and hours, and to show minutes and hours upon four faces, on the external part of the steeple of a new church in Kighley, Yorkshire.

The wheel which strikes the quarters and that for the hours when they came from the foundry, weighed between fifty and sixty pounds of cast brass. The hours are struck in a spiral cut upon a plate screwed to the wheel, like that for which he was rewarded by the Society for the Encouragement of Arts.

It struck him, that if these two wheels could be made without teeth, pins might be put into cast iron as well as brass,

and the difference of the prices of those two metals, and the workmanship necessary for each, would at least be five guineas less in cast iron than cast brass, in two such wheels as the above, for a large church clock. He therefore invented and finished a striking part pursuant to this idea, and although there are many detached escapements for clocks and watches, he knows of no detached striking parts, except this, which is easily and expeditiously made, as it lays aside the train of wheels and pinions, substituting a small part of a circle, at the end of a lever toothed, which is elevated with the hammer, and may be put out of the frame of the clock, turning a fly forwards and backwards. The first motion is to regulate the rapidity with which the hammer would strike, and the latter has nothing to do with the power that struck the hammer, but is acted on by gravity, which will regulate the intervals between the strokes more accurately than any train of wheels and pinions can do with a fly; at the end of which motion it unlocks a detent, which stops against the pins that strike the hammer in the wheel without teeth; and as the elevation of the lever puts forwards the count-wheel one tooth, till one of the twelve pins for the use of counting the hours, or the proper number to be struck, comes into the way of the lever, and then prevents it from unlocking the detent, and the clock gives over striking till the next hour.

It is to be remarked, that if this striking part had turned the fly only one way, the same number of turns could not bridle the rapidity of the motion of the hammer; therefore it follows that the striking part will raise a heavier hammer than any one made to strike with a train of wheels and pinions.

Although the weight of the lever keeps the detent from being locked, it is not necessary it should; for a body in motion requires a great resistance to stop it, as at the end of the back motion of the fly, at which time it unlocks the detent, it has no occasion to be unlocked before, therefore the lever will have more than sufficient pewer to do that business; if it be made as light again as it is, or more, and whatever weight is taken from the lever may be taken from the first power, and still the striking part will elevate as heavy a hammer as before, and the first power or the weight will be more applied to elevate the hammer, and less to do with that which is substituted as a train of wheels or pinions.

In plate LXX, three elevations of this mechanism are given; fig. 1, is a section of the wheels, detents, &c., the front plate of the frame being removed to show them; fig. 2, is a side

view thereof; and fig. 3, shows the count-wheel, which is situated outside of the plate composing the frame; in all these figures the same letters are employed for reference.

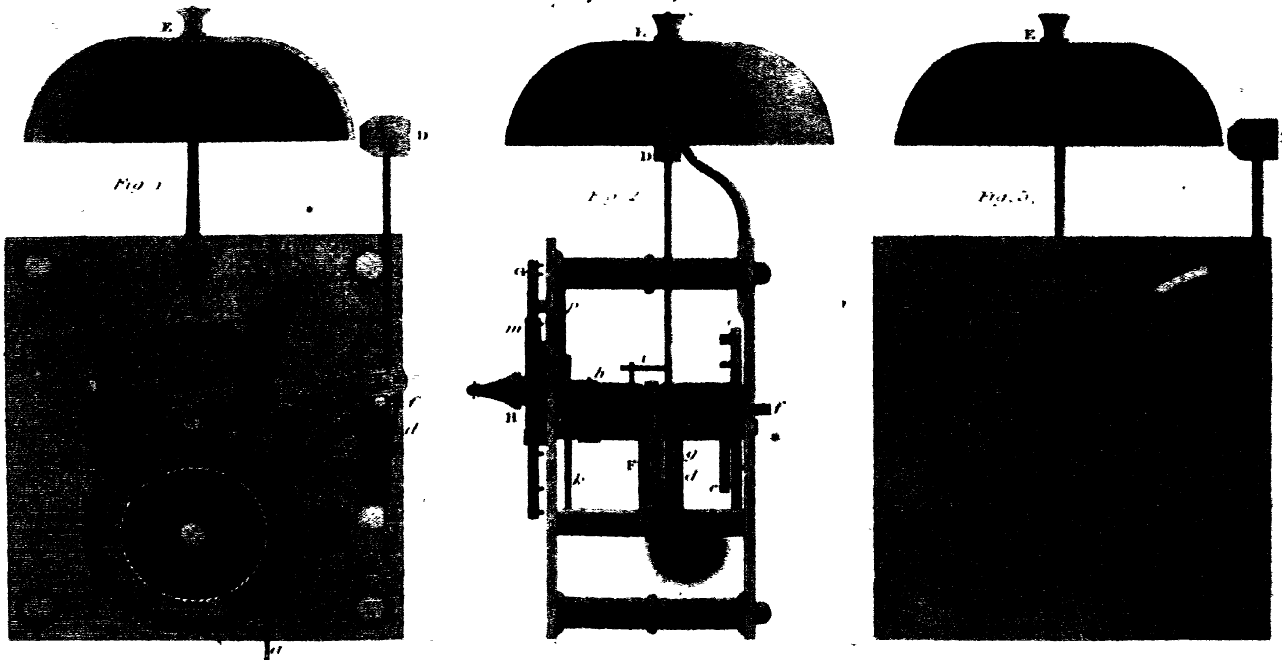
The plate only represents the striking mechanism, detached from the going part of the clock. A, fig. 1, is the barrel for the striking train, with a line *a* wound round it and by means of a weight constantly giving the barrel a tendency to revolve in the direction of the arrow, and turn the wheel B with it, (this barrel and wheel is omitted in fig. 2, to avoid confusion;) the wheel turns a pinion, on the arbor of which is a wheel c, containing thirteen pins, which project from its face, and, as it revolves successively, raise the tail *b* (shown by dots in fig. 1,) of the hammer D; when a pin leaves the hammer tail, the spring *d* throws the hammer against the bell E to strike the hour. This is the train of wheel-work for the striking movement; the detents for the locking and unlocking these are as follows; a detent *e*, fig. 1, fixed to an arbor *f*, extending across the frame, locks the pin-wheel C by receiving one of the pins on its end; the detent is urged into this position by a spring *g*, fig. 2; one of the pivots of the arbor for the hammer is supported in a cock F placed in the centre of the space between the plates; the same pivot hole contains one pivot of another arbor *h*, fig. 2, which is therefore in a right line with the arbor of the hammer, and appears in that figure as if one piece, but in reality has no connexion with the hammer, except that a pin *i*, projecting from the hammer-tail, intercepts another pin fixed into the arbor *h*, so that every time the hammer is thrown back by the pins of the striking wheel raising its tail, the arbor *k* is turned round a small quantity; on this arbor is fixed a long lever K, fig. 1, which has at its extreme end a circular rack of teeth, acting upon a pinion, or an arbor, carrying a fly, such as is always used for the striking movement. The fly is shown edgeways in fig. 1, at *l*, but is omitted in the other figures to avoid confusion; it is this fly which regulates the time of the strokes; their number is ascertained by a count-wheel shown at G, in fig. 3; this is placed to turn round on a stud or pin on the outside of one of the plates of the frame; it has seventy-eight ratchet teeth cut in its circumference, and has a detent, H, moving round on the same centre-pin; this has a piece of watch-spring *m* acting as a click to turn the wheel round when the detent H is lifted up, but when this is let fall its click slips over the teeth of the wheel; *n* is a similar click, but fixed to the frame plate, to prevent the wheel turn-

ing backwards; the count-wheel has pins projecting from it on the side next the frame plate, and these are arranged in the same order as the count-wheel always is, the first pair of pins being situated only one tooth distance; the second interval is two teeth, then three, four, and so on, the interval between the pins increasing one tooth each time up to twelve, making in all seventy-eight teeth; these pins are acted upon by an arm *p*, fastened to the rack K, and having a stud at the end which comes through a circular slit or aperture, (shown in fig. 3,) in the frame plate, and rests upon the pins in the count-wheel at proper intervals.

When the movement is at rest, the pin-wheel *c* is locked by the detent *e*; at every hour this is pushed away from the centre of the wheel by a pin in that wheel of the going part of the clock, which makes one revolution in an hour; the connexion of these parts is not shown in the plate, but it may be done in various ways, as by a pin fixed in the detent, and passing through an aperture in the frame plate, or by a lever affixed to the arbor *f*, fig. 2, of the detent; the means will depend on the kind of clock the movement is applied to; all that is required being to push the end of the detent *e* so far from the centre of the pin-wheel as to unlock its pins.

The weight now sets the whole in motion, and the pins lift up the tail of the hammer to strike the hour; as the hammer is thrown back, it raises the rack K, and turns the pinions and fly as before explained, the motion of the pin-wheel and hammer being regulated by this fly, and prevented from accelerating; when the pin leaves the hammer-tail, the hammer, by its spring, strikes the bell, being detached from the neck and fly in its return, as is evident from inspection of fig. 2, by the time the hammer falls, the locking detent being relieved from the going part of the clock, resumes its original position, and prevents the wheel turning any further; the weight of the rack K causes it to descend, and the fly (turning in a contrary direction to what it did before) regulates the period of its descent; when the rack arrives at the position of fig. 1, it strikes a small arm projecting from the arbor *f*, and by this means pushes the locking-detent away from the wheel which now sets off again, raising the hammer as before.

This explains the application of the fly to regulate the interval between the strokes; but it remains to mention the means by which the proper number of strokes are made. The rack K has a pin projecting from it, and coming through a



Published by Henry [illegible] London 1823

hole in the plate, raises up the lever H, which, as before explained, turns the count-wheel G round one tooth at every stroke of the hammer, but after having made the intended number of strokes, one of the pins of the count-wheel comes into such a position that the arm *p* of the rack rests upon it and prevents the rack descending low enough to reach the arm of the detent *e*; the wheel is now locked, and must wait the expiration of another hour before it resumes its action, by the locking detent being moved by the going part of the clock; but when one stroke is made, the count-wheel being turned round one tooth, the pin is removed from the arm of the rack, and the striking continues till another pin is brought under it; the number of strokes the hammer will make therefore depends on the spaces between the pins in the count-wheel, and these are arranged as before mentioned, and as is well known to all clock-makers.

An Equation Work for a Clock.

A cheap and simple mode of showing the sun's apparent diurnal motion by a clock, will doubtless be considered by many as a useful and convenient improvement in the artificial measure of time. For as the sun's apparent motion is constantly varying from his mean motion, and the difference arising from this variation sometimes amounts to more than a quarter of an hour; and further, if the great perfection which pendulum clocks are arrived at in the present day, and the extreme accuracy with which they are capable of representing mean solar and sidereal motions, are considered, there seems no sufficient reason why an error of such magnitude should be entirely neglected. Agreeably to this idea, the present equation apparatus was invented and applied to a regulator about six years ago, and found to perform extremely well.

The application of the equation of time, or rather, the sun's apparent diurnal motion, to a clock, is by no means a recent discovery. Several clocks of this kind were made nearly a century ago, both in England and in France; but the complexity of their construction, the extreme difficulty of execution, the incapacity of the greater number of workmen, to which

may be added the expense, have operated as insurmountable obstacles to the introducing them into general use: so that, for many years past, clocks of this description have been but little in request, and the making of them laid aside, and almost forgotten.

The first clock of this kind that we have any account of, was found in the cabinet of Charles the Second, King of Spain, about the year 1700, as may be seen in Sully's *Regle Artificielle du Temps*, edit. 1717. But the author of this curious invention did not then appear to be known. Williamson, an English artist, however, in the Philosophical Transactions, No. 363, asserts his right to it, and says he is well satisfied that this clock is one that he made for one Quare, who sold it soon after, to go to the said Charles the Second, King of Spain. Williamson has not given us a description of the mechanism, but merely states that there were two fixed and two moveable circles; the former showing the hour and minute of mean time, the latter, which were concentric to the former, that of apparent time. In the same paper he also tells us, that shortly after he made other clocks for showing apparent time, by raising and depressing the pendulum through a slit in a piece of brass, so that its vibrations would agree with the sun's apparent motion throughout the year.

Equation clocks were first made in France, about the year 1717, by Le Bon and Le Roy; though a project of this kind, by the Father Alexandre, was laid before the Academy of Sciences, as early as 1698. The clocks constructed by Le Bon, scarcely differ from that in the king of Spain's cabinet; they had two concentric circles, one of which was moveable, and its motion was regulated by an equation plate, that performed a revolution in a year. Clocks, and watches too, with moveable circles, have since been made with some improvements, by several French artists; and as far as simplicity is concerned, are perhaps the best of any that have hitherto been constructed.

A much more elegant mode of showing mean and apparent time, is by two minute hands; one of which moves concentrically to the other, and has a piece of brass attached to it representing the sun, to distinguish it from that which points out mean time. Some excellent clocks of this sort have been made by Graham; they have likewise been made in France, by Le Paute, Passement, Berthoud, &c.; but all of them are so extremely complex, that it is no wonder they have not been more generally in use. These clocks require not only an annual motion, in common with all others of the kind, but there is an

addition of several wheels to the minute work, that renders them extremely difficult of execution, and, without great care, liable to considerable sources of error.

The present work has two minute hands; it has no real annual movement, but only a relative one. By these means the construction is rendered simple, and the execution easy. It may be made in less than a week by any ordinary workman who comprehends the use of its parts.

It will be proper first to explain the principle upon which the annual motion is founded; when that is done, the rest will be easily understood. It consists of the difference of velocities of two wheels, that run concentrically to each other; to effect which the following numbers are employed:

111. 79.
137. 64.

If 111 be multiplied by 79 the product will be 8769; an 137 multiplied by 64 gives 8768, the difference being unity. Now if the wheel of 111 teeth be made to revolve in an hour, the end is obtained; for it makes one revolution less in a year than the wheel of 137 teeth. It may be observed, however, that 8768 hours exceed a tropical year by a little more than two hours; but this difference is so extremely small, that in practice it may be altogether neglected, for the error will not become sensible till after several years.

The mechanism will be best explained by a profile. AA, fig. 1, plate LXXI, represents a steel arbor, to which is fixed a nut B of 24 teeth; this arbor also carries the apparent time hand 1. C is the minute wheel of 111 teeth, screwed to a brass socket *b c*, which turns on the arbor AA; the end of this socket is the fore pivot to the arbor, armed with steel, on the extremity of which is the mean time hand 2. The minute wheel drives a wheel D of 64 teeth, keyed on the arbor EE; the fore pivot of this arbor is squared, by which it may be turned at pleasure, so that the equation may be set right, by means of a table, if at any time the clock should have stopped. On the same arbor is fixed another wheel F, of the same diameter, containing 79 teeth, that drives a wheel G of 137 teeth screwed to the socket *g g*; this socket turns freely on the arbor AA, and to it is also screwed the equation plate H. In the periphery of the wheel C there is a stud carrying a toothed quadrant I, which works in the nut B; a pin *i* is fastened in one extremity of the quadrant, which, by the revolving of the equation plate, is moved backwards and forwards; but in order to keep the pin in contact with the plate, a piece of very

narrow watch spring is inserted in the boss of the minute wheel, hollowed out for that purpose; this spring, which ought to be weak, is hooked to the arbor of the nut B.—Fig. 2 represents a front view of the quadrant, nut, and equation plate 2, by which the operation plate may be readily understood.

This apparatus cannot conveniently be placed on the centre pinion so as to derive its motion from it, but motion may be communicated from the movement to the minute wheel in any way the ingenious artist may judge best calculated to suit the particular construction of his clock.

OF DIVIDING THE EQUATION PLATE.

As dividing the equation plate may appear difficult to many, it may be necessary to offer some directions to facilitate the business. For this purpose, the Inventor constructed an Equation Table for a year, divided into 137 parts, each part consisting of an interval of 64 hours, and consequently corresponding to one tooth of the wheel, which carries the equation plate. By this means the operation of dividing the plate is rendered as easy as that of a common snail. The method is as follows:—Having fixed in the extremity of the quadrant a temporary screw with a sharp point, put the minute wheel with the quadrant, and the wheel of 137 teeth with the equation plate upon the arbor AA, and place them in the frame. Hold a piece of iron wire flattened, with one end bent to a right angle, fast to the frame by a hand-vice, with the bent end resting in the teeth of the wheel, so as to retain it in any position. Make fast the minute wheel to the frame by a clamp, the mean time hand pointing exactly to 60 on the minute circle; then bring the apparent time hand to 60 also, and gently strike the screw in the quadrant, whose point will be nearly in contact with the plate, with a hammer, so as to make a small impression; then shift the plate forwards by one tooth of the wheel, and move the apparent time hand forwards, as near as the eye can judge, 39 seconds, (*see the annexed table*) and make a second impression; then move the wheel another tooth, and set the hand to 1 minute 14 seconds; and thus proceed until a series of dots are obtained all round the plate, to which it may be afterwards filed away.

A TABLE USEFUL IN DIVIDING THE EQUATION PLATE.

Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.
0	0	0	37	2	51	15	40	1	29	12	41
+0	39	1	11	2	12	15	57	2	47	12	7
1	14	1	46	1	29	16	8	4	9	11	30
1	46	2	20	—0	42	16	15	5	18	10	50
2	16	2	54	+0	6	16	16	6	28	10	7
2	41	3	25	0	56	16	10	7	36	9	23
3	4	3	55	1	49	15	58	8	40	8	37
3	22	4	22	2	43	15	41	9	40	7	49
3	37	4	47	3	38	15	17	10	35	7	1
3	48	5	8	4	33	14	47	11	25	6	11
3	55	5	27	5	29	14	12	12	9	5	22
3	58	5	42	6	25	13	29	12	47	4	32
3	56	5	54	7	21	12	43	13	20	3	43
3	50	6	2	8	16	11	50	13	47	2	55
3	41	6	6	9	10	10	54	14	7	2	8
3	27	6	5	10	1	9	52	14	23	1	23
3	10	6	0	10	52	8	42	14	32	0	40
2	49	5	51	11	40	7	36	14	36	0	0
2	26	5	37	12	26	6	24	14	35		
2	0	5	19	13	8	5	8	14	28		
1	32	4	57	13	47	3	50	14	16		
1	2	4	31	14	22	2	30	13	59		
+0	30	4	1	14	52	+1	10	13	37		
—0	4	3	28	15	19	—0	10	13	10		

Description of a Sector, for giving the proportionable Sizes of Wheels, Pinions, &c.

The Author of the present essay having found, by repeated experiments, this instrument to be of very singular use, is induced to present it to the public; not only from a desire of its being farther serviceable to himself, but from the hope of extending its utility to the profession in general.

He does not himself claim the invention wholly, the principle in some measure being taken from an instrument invented by the late ingenious Mr. Downs: but finding this very inadequate to the purpose, he was induced to attempt an improvement: and hopes he has succeeded in some degree, when it is considered that the old instrument answered no other purpose than simply giving the proper distance of the centres of a wheel and pinion, for the wheel to carry the pinion, (commonly called a proper depth,) by having the wheel given; and that only laid down on the instrument, by experiment, for wheels and pinions of every different number, at least as far as he has been able to learn; nor does it appear, from the principle upon which it is constructed, that there could possibly be any other method.

The sector, here offered to the public, gives, in the most accurate manner, the porportionable dimensions of wheels and pinions; also in drawing circles, and setting their centres at a proper distance in drawing callipers: this will be particularly useful, and has he believes never been before attempted. It likewise gives the proper depth for a wheel and pinion, by only having the wheel given, with the help of the tables annexed.

The description subjoined of the instrument and its different uses, together with the method of constructing the tables, he has endeavoured to make as intelligible as possible; and hopes he has been so far successful as to enable any tolerable workman, with moderate attention, to make one from it himself.

Being well assured of the great use of the instrument, he is in hopes of seeing it adopted by men of skill in the profession, under whose hands it will doubtless receive much improvement. The only objection that it seems liable to is, when a pinion is an improper size, or the leaves not a proper shape, it will not set them a good depth; but he ventures to affirm, from a number of experiments, that they must be exceedingly bad indeed before any sensible error will be perceived; and such as ought

not to be admitted into any tolerable work : when this is considered, the objection will be of little weight.

The plate represents the exact size of this instrument; for a watch-maker's purpose : the clock-maker will require one proportionably larger.

This sector is composed of the legs A and B, plate LXXI, (fig. 4,) and the joint C, and divided into 100 (as appears by the figure) on one side, and on the other side into 150, in the manner shown at fig. 5. At the 50th division, and having its centre exactly on the edge of the leg A, is fixed the piece D; and on the same part of the leg B is fixed the socket E, with the moveable cylinder F going through it; and which may be fastened, at any place required, by the screw G. Fig. 6 is another view of the socket, &c. the same letters refer to each.

H and I (fig. 4,) are pieces screwed upon the leg A, having their edges next each other filed shelving, so as to form a dovetail groove, in which the pieces K and L slide; the piece L has a notch through it from one end to the other, to admit the piece *a*, which goes through both it and the leg of the sector, and has a nut screwed on the other side, to fasten it at any place; the pieces K and L are connected together by the screw M, the use of which is to set the piece K exactly to the place required: on this piece is screwed the piece N, which lies over the edge of the leg A; it has likewise on it a nonius of 10. O is an arch fixed to the leg A, and on which the end of the leg B moves; P a piece fitted upon the arch O, and moveable upon it, and which may be fastened at any place by the piece *b*, going through it, and having a nut screwed upon it on the other side; the piece P and the leg B are connected together by the screw Q, the use of which is to set the leg B exactly to the place required.

THE USE OF THE SECTOR.

I. *To find the proportionable sizes of wheels and pinions.*

Look for the number of the wheel on the sector, then open it till the diameter of the wheel just reaches from one leg to the other, even with the number; the diameter of the pinion will then be even with the number in the small table annexed, as ascertained by a great many experiments.

Leaves of the Pinions.	Numbers on the Sector.	Leaves of the Pinions.	Number on the Sector.
6	7.2	10	10.8
7	8.1	11	11.7
8	9.0	12	12.6
9	9.9		

II. *To draw circles the proportionable sizes of wheels and pinions.*

The line drawn from the centre of the joint, and which is called the line of lines, or equal parts, and divided into 150, (fig. 5) is for the convenience of setting the compasses, to take the sizes, and answers the same purpose for circles as the edges of the sector does for wheels and pinions.

III. *To set the centres of circles at a proper distance from each other in drawing callipers.*

Having the numbers of the wheel and pinion, and the diameter of the wheel, look for the number opposite that of the pinion, in the small table annexed; and subtract that from the number of the wheel:—

Leaves of the Pinions.	Numbers on the Sector.	Leaves of the Pinions.	Numbers on the Sector.
6	3.8	10	7.0
7	4.6	11	7.7
8	5.7	12	8.3
9	6.4		

This table is constructed by experiments with wheels and pinions, as appears by fig. 7 of the plate for pinions of six, the wheel 48 and pinion of six being at a proper distance and having their centres even with the 24th division, the diameter of the wheel touches the lines just three divisions and $\frac{8}{10}$ths from

Durand's Machine for Breaking & Scutching Hemp or Flax.

Fig. 2.

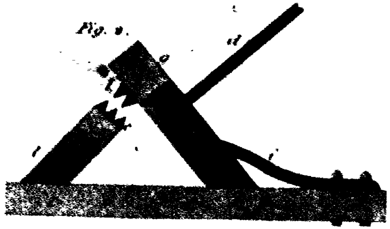
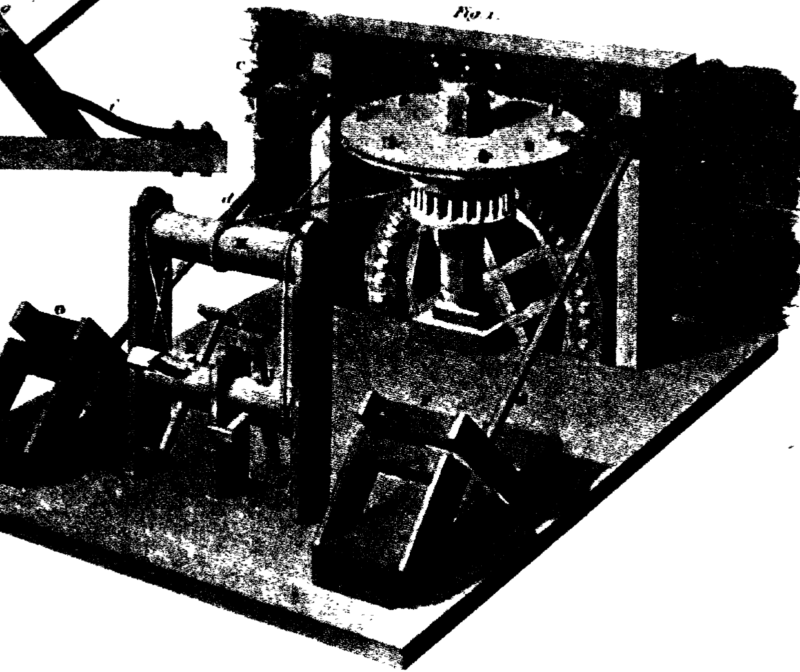
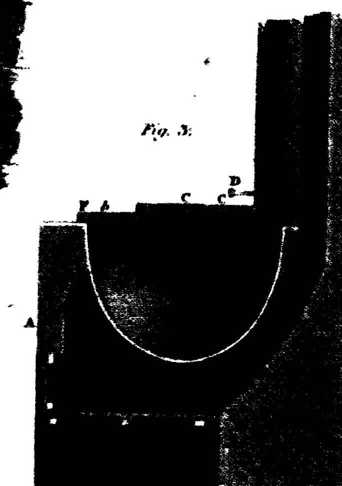


Fig. 1.



Webster's Method of preventing Annoyance from the Steam of Boilers

Fig. 3.



Published by Nuttall, Fisher & Dixon, Liverpool, March 1813.

the 48th division. The same rule will do for every other wheel.

For example :—Suppose a wheel of 48 teeth and a pinion of 6 leaves: in the table, opposite 6, you find 3.8; which you subtract decimally from 48: thus 48.0 — 3.8 = 44.2, which produces 44 and $\frac{2}{10}$; then take the diameter of the wheel in your compasses, set one foot on 44.2 on one leg, and open the sector till the other falls on the same number on the other leg; the distance then between half 48, on each leg, will be the distance of the two centres, for the wheel to carry the pinion, as appears by fig. 7 of the plate. A and B are the supposed lines, drawn apart from the sector, for the convenience of having the wheel and pinion larger. G a wheel of 48; and D a pinion of 6.

IV. *To set wheels and pinions the proper depth in each other, by only having the wheels given.*

At H (fig. 4,) are divisions corresponding with those on the edge of the sector, only numbered the contrary way, beginning at the 100th; and these are the divisions to be observed in this case; by means of the nonius, on the piece K, the edge of the piece N may be set the 10th part of one of the divisions, and answers the same purpose as if every single one were actually divided into 10; so that in using it for this purpose every single division must be called 10, the 10 a 100, &c. Suppose a wheel of 48 teeth and a pinion of 6 leaves to be set a proper depth, look in the table for pinions of 6, and opposite 48 you will find 79.1, which is 79 and $\frac{1}{10}$th of the small imaginary divisions before mentioned; so that you set the cipher on the nonius as far beyond the 7th division as till the 9th on it corresponds with one of the other divisions, (the fractional part in this case need not be taken notice of;) then, if the wheel be applied to the edge of the sector, close to the piece N, and the legs be brought together until it reaches the same part on each leg, the points at D and F will give the proper distance.

The method of constructing the following tables is thus :— divide 1000 (which is the number the sector is supposed to be divided into) by the number of the wheel, and multiply this product by the number opposite to that of the pinion, in the second table, p. 468; and this will be the number for that wheel. The sector may be divided into any number which may be judged most convenient; and the same rule will continue to answer in the construction of the tables.

TABLE I.—PINIONS OF SIX LEAVES.

No. of Teeth in the Wheel	Nos. on the SECTOR	No. of Teeth in the Wheel	Nos. on the SECTOR.	No. of Teeth in the Wheel.	Nos. on the SECTOR.	No. of Teeth in the Wheel.	Nos. on the SECTOR	No. of Teeth in the Wheel	Nos. on the SECTOR.
24	158.3	40	95.0	56	67.8	72	52.7	96	39.5
25	152.0	41	92.6	57	66.6	73	52.0	98	38.7
26	146.1	42	90.1	58	65.5	74	51.3	100	38.0
27	140.7	43	88.3	59	64.4	75	50.6	102	37.2
28	135.7	44	86.3	60	63.3	76	49.9	104	36.5
29	131.0	45	84.4	61	62.2	77	49.3	106	35.8
30	126.6	46	82.6	62	61.2	78	48.7	108	35.1
31	122.5	47	80.7	63	60.2	79	48.1	110	34.5
32	118.7	48	79.1	64	59.3	80	47.5	112	33.9
33	114.1	49	77.5	65	58.3	82	46.3	114	33.3
34	111.7	50	76.0	66	57.0	84	45.2	116	32.7
35	108.4	51	75.4	67	56.7	86	44.1	118	32.2
36	105.5	52	73.0	68	55.8	88	43.1	120	31.6
37	102.7	53	71.6	69	55.0	90	42.2	....	....
38	100.0	54	70.3	70	54.2	92	41.3	....	....
39	97.4	55	69.0	71	53.6	94	40.3	....	....

TABLE II.—PINIONS OF SEVEN LEAVES.

No. of Teeth in the Wheel.	Nos. on the SECTOR.	No. of Teeth in the Wheel	Nos. on the SECTOR	No. of Teeth in the Wheel	Nos. on the SECTOR	No. of Teeth in the Wheel	Nos. on the SECTOR.	No. of Teeth in the Wheel	Nos. on the SECTOR
28	164.2	43	106.9	58	79.3	73	63.0	96	47.9
29	158.6	44	104.5	59	77.9	74	62.1	98	46.9
30	153.3	45	102.2	60	76.6	75	61.3	100	46.0
31	148.3	46	100.0	61	75.4	76	60.5	102	45.0
32	143.7	47	97.8	62	74.1	77	59.7	104	44.2
33	139.3	48	95.8	63	73.0	78	59.0	106	43.3
34	135.2	49	93.8	64	71.8	79	58.2	108	42.5
35	131.4	50	92.0	65	70.6	80	57.5	110	41.8
36	127.7	51	90.1	66	69.6	82	56.0	112	41.0
37	124.3	52	88.4	67	68.6	84	54.7	114	40.3
38	121.0	53	86.7	68	67.6	86	53.4	116	39.6
39	118.0	54	85.1	69	66.6	88	52.2	118	38.9
40	115.0	55	83.6	70	65.7	90	51.1	120	38.3
41	112.1	56	82.1	71	64.9	92	50.0	122	37.7
42	109.5	57	80.7	72	63.8	94	48.9	124	37.0

Pennington's sector for proportioning wheels and pinions.

TABLE III.—PINIONS OF EIGHT LEAVES.

No. of Teeth in the Wheel	Nos. on the SECTOR	No. of Teeth in the Wheel	Nos. on the SECTOR	No. of Teeth in the Wheel.	Nos. on the SECTOR.	No. of Teeth in the Wheel.	Nos. on the SECTOR.	No. of Teeth in the Wheel	Nos. on the SECTOR.
32	178.1	48	118.7	64	89.0	80	71.2	112	50.8
33	172.7	49	116.3	65	87.5	82	68.5	114	50.0
34	167.6	50	114.0	66	86.3	84	67.8	116	49.1
35	162.8	51	111.7	67	85.0	86	65.2	118	48.3
36	158.3	52	109.6	68	83.8	88	64.7	120	47.4
37	154.0	53	107.5	69	82.3	90	63.3	122	47.2
38	150.0	54	105.5	70	81.4	92	61.9	124	45.9
39	146.2	55	103.6	71	80.5	94	60.6	126	45.2
40	142.5	56	101.7	72	79.1	96	59.3	128	44.5
41	139.0	57	100.0	73	78.0	98	58.1	130	43.7
42	135.7	58	98.2	74	77.0	100	57.0	132	43.1
43	132.5	59	96.6	75	76.0	102	55.8	134	42.5
44	129.5	60	94.9	76	75.0	104	54.8	136	41.9
45	126.6	61	93.4	77	74.0	106	53.7	....	....
46	123.9	62	91.9	78	73.1	108	52.7	....	....
47	121.2	63	90.4	79	72.1	110	51.8	....	....

TABLE IV.—PINIONS OF TEN LEAVES.

No. of Teeth in the Wheel	Nos. on the SECTOR	No. of Teeth in the Wheel.	Nos. on the SECTOR.	No. of Teeth in the Wheel	Nos. on the SECTOR	No. of Teeth in the Wheel	Nos. on the SECTOR.	No. of Teeth in the Wheel	Nos. on the SECTOR
40	175.0	55	127.2	70	100.0	88	79.3	116	60.3
41	170.7	56	124.9	71	98.8	90	77.0	118	59.3
42	166.6	57	122.8	72	97.9	92	76.0	120	58.3
43	162.7	58	120.6	73	95.8	94	74.4	122	57.3
44	158.0	59	118.6	74	94.5	96	72.9	124	56.4
45	155.0	60	116.6	75	93.3	98	71.4	126	55.5
46	152.1	61	114.7	76	92.1	100	70.0	128	54.6
47	148.9	62	112.9	77	90.9	102	68.6	130	53.7
48	145.8	63	111.1	78	89.7	104	67.3	132	53.0
49	142.8	64	109.3	79	88.6	106	66.0	134	52.2
50	140.0	65	107.4	80	87.0	108	64.8	136	51.4
51	137.2	66	106.0	82	85.3	110	63.6	....	....
52	134.6	67	104.4	84	83.3	112	62.4	....	....
53	132.0	68	102.9	86	81.3	114	61.4	....	....
54	129.6	69	101.4						

TABLE V.—PINIONS OF TWELVE LEAVES.

No. of Teeth in the Wheel	Nos. on the SECTOR.	No. of Teeth in the Wheel.	Nos. on the SECTOR.	No. of Teeth in the Wheel.	Nos. on the SECTOR.	No. of Teeth in the Wheel.	Nos. on the SECTOR.	No. of Teeth in the Wheel.	Nos. on the SECTOR
48	172.9	62	133.8	76	109.2	100	83.0	126	65.6
49	169.3	63	131.7	77	107.7	102	81.3	128	64.8
50	166 0	64	129.6	78	106 4	104	79.8	130	63.3
51	162.7	65	127.4	79	105.0	106	78.3	132	62.8
52	159 6	66	125.7	80	103.7	108	76.8	134	61.9
53	156.6	67	123.8	82	101.2	110	75.4	136	61.0
54	153.7	68	122.0	84	98.0	112	74.1	138	60.1
55	150.9	69	120.2	86	96.5	114	72.8	140	59.2
56	148.2	70	118.5	88	94.3	116	71.5	142	58.6
57	145.6	71	117.2	90	92.2	118	70.3	144	57.1
58	143.1	72	115.2	92	90.2	120	69.1	....	....
59	140.6	73	113.5	94	88.2	122	68 0	....	....
60	138.3	74	112.1	96	86.4	124	66 9	....	....
61	136.0	75	110.6	98	84 6				

A new and correct Method of squaring a Hand Rail round the Winders of a Stair-case, so as to be got out of the thinnest Plank possible, and to cut it out to the greatest Advantage, in order to match the Grain of the Wood.

The following new and correct method of squaring hand-rails round the winders of stair-cases, depends upon the section of a cylinder cut through any three given points on its surface.

By the application of this principle, the quantity of stuff used in the construction of hand-rails, may be very considerably reduced. It will not only enable the workman to cut out the plank in a most advantageous manner for matching the grain of the wood, but will likewise allow of his using the thinnest stuff possible. It is also useful in all works where both plan and elevation are circular, particularly where a cylindric wall is excavated by cylindric openings, and in the

construction of archivaults for finishing such windows. Its universality is such, that it may be applied to the angular ribs of cylindro-cylindric groins (such as those in the entry to Somerset House) to spherical niches in circular walls, and to all groins that are circular upon the plan.

Its advantages are incalculable in all works of double curvature, owing to the great facility with which the principle is applied, and the immense saving of time, as well as material, attending its application. It entirely supersedes the use of the centre or cylinder, which has hitherto been used to fit the work upon by way of trial, and will enable the mechanic to bring the work to its form in much less time than he has usually employed in preparing the centre.

The use of this principle is not confined to wood-work, but may be employed in all kinds of masonry where works of double curvature occur.

HAND-RAILING.

Hand-railing is the art of forming hand-rails by moulds, according to geometrical rules. The principles upon which this art depends, are, that of cutting a right prism through any three given points in space, and that of forming a developement of any portion of the surface of the prism.

In order to illustrate this, let the interior surface of the surrounding wall be that of an entire cylinder, and let the breadth of the steps be divided into the fustrums of equal and similar sectors, and let the heights be all equal, as is universally the case; then, if an interior cylindric surface be erected concentric with the wall, and the ends of the steps or surfaces on which we tread, and the planes of the risers tending to the axis be supposed to meet the interior cylindric surface, it is evident that if the portion of the intercepted surface contained between the indented line formed by the ends of the steps, and the circumferent line at the base be developed or stretched out, all the points of the indented line formed by the outward or salient angles, will be in the same straight line, and all the points formed by the inward or re-entrant angles will be in another straight line. It is also evident, that this will not only be the case with cylinders, but with cylindroids, and every other description of prism; that is, the points of the developement of the indented line will always have such a position,

that two straight lines parallel to each other, may be drawn through the whole number of points.

The points of concourse of the salient angles, are called the nosings of the steps.

The line drawn through all the nosings of the steps, is called the line of the nosings.

Now let the portion of the cylinder before uncovered, be again enveloped, the developement in this state becomes an envelope, and the line of nosings becomes an uniform helix, which would be the form of the rail for such a stair.

In this case it would be easy to execute the rail to any length we please, in equal portions succeeding each other; for as the curvature of the helical line is every-where the same, the same moulds which are used in the formation of one piece, would serve for every succeeding piece.

The steps placed around the circular part are termed winders; in these the risers tend to the axis of the cylinder.

Steps which have their treads the same breadth, are termed flyers; in these the risers are all parallel.

Very few stair-cases are however entirely circular, but those of the semi-circular form, with winders in the semi-circle, and flyers below and above, are very numerous; in such the line of nosings would be crooked, and would form an angle at the junction of the flyers and the winders, and that round the semi-circle would be a helix, consisting of half a revolution.

In the developement of the steps, the line of nosings would consist of three straight lines, the two straight lines through the nosings of the flyers would be parallel to each other, and each extremity of the middle one would join one extremity of each of the other two; the angles are commonly taken away by introducing a curve in their places.

A hand-rail, however, is not a mere helical line, but a solid, which may be contained between two concentric cylindric surfaces, or concentric prismatic surfaces. The principles are the same, whatever be the form of the plan. A solid erected upon any plan, is called a prism; a cylinder is therefore a round prism, and a cylindroid an elliptic prism. A hand-rail may stand upon a circular base, or partly circular and partly straight, or upon an entire elliptic base. In the construction of hand-rails, all prisms are excluded which consist of plain surfaces, or, which is the same thing, where the sides of the plan consist entirely of straight lines, as in such cases, the rails themselves are either straight, or partly curved and partly

straight from the top and lower sides only, the sides being in vertical planes.

We shall therefore confine ourselves to prisms that stand upon a circular base, or upon an elliptic base, or upon a base that is partly circular and partly straight, or, lastly, upon a base that is partly elliptical and partly straight. These two last may be said to have compounded bases or plans, and the former two simple bases or plans; let us call such a prism a curved prism.

The plan of any curved prism is understood to be of the same breadth, and consequently the solid erected thereon will be every-where of the same thickness. The prism may therefore be a hollow cylinder, or a hollow cylindroid, or a concave body partly cylindric and partly straight; the latter may be open on one side, and may have the four planes which join the curved surfaces parallel to each other, and tangent to each of the cylindric surfaces.

Let us therefore suppose such a prism as that last mentioned, and let us suppose it to be cut entirely through its vertical surfaces, in such a manner that any point in the surface of division may coincide with a straight line every-where perpendicular to the external prismatic surface, then, every such line will be parallel to the plane of its base, and those lines in the cylindrical part of the prism will tend to the axis. Now it is evident, that the cut or dividing surface will not be a plane, but will wind or twist between the cylindric surfaces. It is also evident, that the cut may pass through a line drawn in any manner we please, in one of the prismatic surfaces; or, that the developement of this line may have any degree of curvature in the whole length, or in any portion of the length, or may even be a straight line. One of those being supposed to be the case, let the upper part of the prism be taken away, then the upper surface of its remaining part will be brought to view; let a line be drawn on the exterior surface, parallel to the arris, and another on the concave side, parallel to its arris; and let another cut or dividing surface be made to pass through the two lines thus drawn, and let the upper part be removed by this division, then the part thus removed will form a solid helix or kind of half screw, which may be either uniform in its upper and lower surfaces, or have any degree of curvature in any part that may be required, according to the developement before mentioned. This is the form of the rail for such a stair, but to form the solid helix, without cutting it, from a hollow curved prism, is the thing required to be done in hand-railing.

Now, seeing that two of its sides are actually cylindrical, and would be vertical if placed in position; and that the other two winding surfaces may be formed to any developement we please; let us therefore take any determinate portion of the helical solid, as a quarter of a revolution, or perhaps something more, as occasion may require, and endeavour to form such a portion or wreath out of a thin plank, instead of cutting it from a solid curved prism. Before this can be done, it is necessary to understand the principle of cutting a prism through any three fixed points in space, by a plane passing through these points; the points may be in the surface of the prism itself, and may be either all in the concave side, or all in the convex side; or partly in the concave side, and partly in the convex side;—That such a supposition is possible will readily appear, since any three points are always in the same plane; and, therefore, the plane may cut the prism through any three given points.

The three points through which the section is cut, are said to be given, when the seats are given on the plane of the base of the prism, which plane is understood to be at right angles to the axis of the prism, and when the distances or heights from the seats to the points themselves, are given.

It is always to be understood, that the three seats are not in a straight line, and consequently the three points themselves not in a straight line.

The seat of a point in space on any plane, is that point in the plane, where a perpendicular drawn through the point in space, cuts the plane.

This being established, we shall proceed to show the best means of applying these principles to hand-railing.

In the helical solid, the winding surface connecting the two prismatic surfaces, was defined to be of such a property, as to coincide with a straight line perpendicular to the exterior prismatic surface, and consequently, if the axis of the curved prism be perpendicular to the horizon, every such line will be parallel to the base; now, let the seats of three such lines be given on the plan, viz. let each extreme boundary be one, and let another be taken in the convex side, passing through the point which would give the middle of the developement of the said side of the plan; the three seats would be terminated by the convex and concave sides of the plan, and will always be perpendicular to the convex side, and equal in length to each other. Let us call the three level lines, of which their seats are given, the lines of support; let a plane be laid on the

three lines of support, the plane will either rest upon three points or upon one of the said lines and two points; it is evident that the points which come in contact with the plane, will be at one extremity of each line of support; let each of these points which come in contact with the plane thus posited, be called a resting point. The three resting points are the three points in space, through which the plane is supposed to pass, that cuts the curved prism.

Now, because that each line of support has two extremities, there will be six extreme points in all, but as only three can be resting points, unless the plane coincides with one of the lines of support, it will be proper to show, which three of the six are the resting points. Let the plane, thus laid upon some three extremities of the lines of support, be continued to intersect the base of the curved prism, then the nearest extremity of the seat of any line of support to the intersecting line, is the seat of the resting point of that line.

For this purpose let a developement of the convex side of the rail be made according to the plan and rise of the steps. The part of this developement that is made to bend round the convex or concave cylindric surface of the helical portion or wreath, is called a falling mould, which is supposed to be brought to an equal breadth throughout its length. Only one falling mould is used in the construction of hand-rails. Let, therefore, the falling mould for the convex side be constructed, and let two straight lines be drawn from the ends of the upper edge of that part of the falling mould corresponding to the ends of the wreath, perpendicular to the base of the whole developement; also, let another intermediate line be drawn parallel to the other two, so as to bisect the part of the base intercepted by the said two parallels: the three parallels will thus give the heights of the three resting points, the shortest height is at one extreme, and the longest at the other. Suppose now, the shortest of these three heights taken from each of the three, and the remainders taken at heights, instead of the whole, then the height of the first resting point will be nothing, and will therefore coincide with its seat; then, if the middle height be less than half the length of the remaining height, the seats of the resting points will be the first and second extremities of the first and second lines of support taken on the convex side, and the extremity of the third on the concave side. The first resting point is a point in the intersection of the plane of the base, with the inclined plane.

The process is now completely reduced to that of finding the section of a prism through three given points, which suppose to be done, and the plane of section will touch the supposed wreath, at the resting points of each line of support, without cutting the wreath of any such line—then, the three lines of support will be on the same side of the plane, viz. on the under side. Let us suppose now, another section taken below, and parallel to the former, so that the wreath may be just contained between these parallel sections, or planes; the distance between the two sections, will represent the thickness of the plank.

The section of the prism through its vertical surfaces, is called the rake, or the rake of the plan: and a mould being cut to the rake, is called the face-mould.

The above are the general principles; the particulars will be best understood by the explanations which accompany the following diagrams, referring to plates 72 and 73.

Let fig. 1, No. 1, plate LXXII, be the plan of a geometrical stair, with eight winders in the semi-circle, and flyers above and below; the first or lower steps being denoted by the scroll *a*; let *q l p m r* be the plan of the part of the rail that is to be formed in two wreaths; and *q l* and *m r* straight parts; in order for the better securing of the wreaths, to the straight parts opposite the flyers.

Let fig. 1, No. 2, be the developement of twelve steps, including that of eight winders, two flyers below and two above; DB being the base, and BC the height. In the base DB, No. 2, LPM is the developement of *l p m*, No. 1, and LD, MB, the breadths of two steps corresponding to the plan. In the height BC, NO is the height of the winders, and NB, OC, each the height of two steps answering to the flyers at each end. DEFC, is the line of nosings; the parts DE, FC, of the flyers, being parallel to each other, and joined by the part EF, the developement of the winders; GRH, and ISK are curves tanged by the straight lines ED, EF, and FE, FC, at the points G, H, I, K, or rounded off, as shown at No. 3, on a longer scale, so as to form an agreeable curved line without angles.

The line GRHISK may be called the line of the rail, being of the same form as the line bisecting the breadth of the developement of the rail, for the one may be supposed to be every-where of the same height from that of the other, and therefore, the line GRHISK, may be conceived to be the developement of the rail.

Nicholson's mode of squaring hand-rails.

No. 3 shows the manner of drawing the tanged curves GRH, and ISK; No. 2 the upper one ISK, being the same as the lower one GRH, but inverted.

No. 2 shows more lines than are wanted in practice, in order to show the connection between the developement of the steps, and the developement of the line of the rail. But, as the developement of the line of the rail is all that is wanted, make *a b*, No. 4, equal to the height of the winders, draw *a c* and *d b*, at right angles each with *a b*; make *a e* and *b f* each equal to the developement of *l p* or *p m*, No. 1; make *e c*, and *f d*, the breadth of a step; draw *c g* and *d k* parallel to *a b*; make *c g* and *d k* each equal to the height of a step; join *e g f k*, and *e f*; make *e h* equal to *e g*, and *f i* equal to *f k*, and draw the tanged curves *g r h* and *i s k* as before; then *g r h i s k*, will be the line of the rail, as in No. 2; for *e f* will be obtained, equal to EF, No. 2; and *e l g* will be the section of a flyer at the lower end, and *f d k* the section of a flyer at the upper end. The breadth of the falling mould, in common cases, is about two inches, therefore, two lines being drawn parallel to the line of the rail, each at an inch distance from it, gives the complete falling mould for both wreaths. The two parts of the falling mould, as divided by *a b*, are equal and similar to each other, and would therefore coincide if applied together.

Let fig. 2, No. 1, be an enlarged plan of the rail, of double dimensions to No. 1, fig. 1, in order that the moulds may be more exactly obtained, and the construction more clearly seen. Let ABCDEFG, fig. 2, No. 3, be the plan of the part of the wreath to be formed, AG being the seat of the line of support at the lowest part, and DE that at the highest part: then A is the seat of the resting point of the lowest end, and E that at the highest end. Take the point C, between A and D, so that C, in the developement of the line ABCD, may divide the said developement into two equal parts.

Let ABCD, fig. 2, No. 2, be the developement of the curve ABCD, No. 3; the parts AB, BC, CD, being the respective developements of AB, BC, CD, No. 3. In No. 2, draw DK perpendicular to DB; and make DK equal to the height of eight steps; draw KS parallel and equal to DB; join BS; produce KS to T, and DB to V; make ST and BV each equal to the breadth of a step; draw TU and VW parallel to DK; make TU and VW equal to the height of a step; join WB, BS, SU: then WBSU is the line of nosings. The whole is

completed as in No. 3, fig. 1. Draw AX parallel to KD, cutting the upper side of the falling mould at X; draw XZ parallel to AD; produce KD to Z, and let KD cut the top of the rail at I; through C draw YJ, parallel to DK, cutting the top of the rail at J, and XZ at Y; then YJ and ZI, respectively, are the height of the resting points, whose seats are C and E, No. 3. In No. 2, draw JR parallel to BD, cutting DK at R. In No. 3, join the seats E and C, of the resting points, and produce EC to L. In JR, No. 2, find the point O, by making RO equal to EC, No. 3; join IO, and produce IO to meet XZ at Q. In No. 3, make EL equal to ZQ, No. 2, and join AL; through G draw HK, perpendicular to AL, and produce LA to H; through E draw E *i* parallel to LH, cutting HK at I; make I *i* equal to ZI, No. 2, and join H *i*, and produce H *i* to *k*. To find any point in the curve of the section, take any point M in the boundary of the plan, and draw M *p* parallel to E *i*, cutting H *i* at *p* and HI at P; draw *p m* at right angles to H *i*, and make *p m* equal to PM, and *m* is a point in the boundary of the rake. In like manner, let MP cut the concave side of the plan at N; in *p m* take *p n* equal to PN, and *n* is a point in the concave side. A sufficient number of points being thus found, draw a mixed line, *a b c d e f g*, through the whole, and *a b c d e f g* is the figure of the rake. For greater accuracy and despatch, it will be necessary to find a point in the rake corresponding to the extremity of every straight line in the plan, as shown by small letters of the same names as the capitals on the plan. The part ABFG being a parallogram on the plan; the corresponding part *a b f g*, on the section, is also a parallelogram; in this case it will be only necessary to find the points *a*, *g*, *f*. Join *a g* and *g f*; draw *a b* parallel to *g f*, and *f b* parallel to *g a*, and the point *b* gives the commencement of the convex curve *b c d*, and the point *f* that of the concave curve. It remains to be shown that HL, No. 3, is the intersection of the plane on which the section of the prism is formed; for the point A is not only the seat of the lowest resting point, but the resting point itself. A is therefore the point in the intersection of the cutting plane. In No. 2, draw O △ parallel to KZ, cutting BZ at △; conceive the triangle IQZ to be removed to No. 3, so that the point Z may be upon E; and because RO △ Z is a parellogram, △ Z is equal to RO, and RO is equal to EC by construction; therefore the point △ will fall upon C: and by construction, the point Q will fall upon L. Conceive the triangle, with its base, thus coincident with

LE, to be raised perpendicularly to the plan; I will be the resting point over E, and O the resting point over C; therefore the points I and E will be in the plane of section, and consequently be the straight line IOQ; but the point Q, now supposed to be coincident with L, is common to the plane of the base; and the plane of section, Q, is therefore a point in the intersection of the cutting plane and the base. The point A has likewise been shown to be a point in the intersection; therefore the straight line HL, passing through the points A and L, is the intersection of the cutting plane with the plane of the base. The point L, No. 3, will be obtained also by a fourth proportional to IR, IZ, RO, or Z △, No. 1, setting it from E to L.

A mould being cut to the form of the section, as here obtained, is called by workmen, the *face mould*, which we shall suppose now to be made.

TO FIND THE THICKNESS OF THE PLANK, OUT OF WHICH THE WREATH IS TO BE CUT.

Let ZI, No. 2, cut the under edge of the falling mould, at ε, transfer Z ε upon K *k*, No. 3, from K to δ; then the nearest distance between the point δ and the straight line H *k*, is the thickness of the stuff at the upper joint.

The wreath, when formed into two prismatic surfaces, and into two winding surfaces, is said to be squared. This formation is all that is required from geometrical principles. Then, supposing the wreath set in its proper position, every section made by a vertical plane, perpendicular to the convex side of the plan, will be a quadrilateral with its two vertical sides parallel, and at right angles to the upper side, and at oblique angles to the lower side. This arises from the top being so formed as to coincide in every part with the line perpendicular to the prismatic surface as defined, and the lower winding surface by gauging upon each cylindrical surface from the top.

TO DRAW THE RAKE ON THE SLIDES OF THE PLANK, IN ORDER TO PLUMP THE TWO SIDES OF THE WREATH.

Let ABCD, fig. 3. No. 1, be a developement of three sides of plank; let AE, HD, be the top; EF, GH, the edge, in breadth equal to the thickness of the stuff obtained from No. 3, and FB, CG, the under sides; let the lines EH and FG, be parallel to *k* H, fig. 2, No. 3, in order to be more easily comprehended (as otherwise, it is not necessary,) let *a b c d e f*, on the top of the plank, be the rake formed by the face-mould, the point *g* being in the line HE, and the line *g e*, making the same angle with *g* E as the line *g e*, fig. 2, No. 3, makes with *g k*, draw *g* K, making the angle H *g* K equal to the angle H *k* K, or H *i* I, or H *p* P, fig. 2, No. 3, cutting the arris, fig. 3, No. 1, GF, at K, then the same mould being drawn on the under side, with the point *g* at K, and the chord *e g* making the same angle with KF, that *e g*, on the upper side, makes with *g* E, or the distance of the point *e* from GF, on the lower side, equal to the distance of the point *e* from HE, on the upper side. Let us now suppose lines drawn in the above manner upon the three corresponding surfaces of the plank to that of the figure, and let the plank be cut out with a bow saw. In the act of cutting, the kerf must be kept close to the corresponding lines of each rake, and the line of the teeth of the saw parallel to *g* K, and when the piece of the wreath is entirely divested of the superfluous wood, the sides thus formed will be plumbed.

TO DRAW THE RAKE UPON THE PLANK IN EVERY POSITION TO THE ADJOINING ARRIS OF THE EDGE.

Let fig. 3, No. 2, be a developement of the plank as before, the same letters referring to the same parts. Let *a b c d e f g* be the rake drawn by the face-mould, the point *g* being in the arris HE, and the chord *g e* forming any given angle with the arris HE, less than that formed in No. 1, fig. 3, by the chord *g e*, and the arris HE; find *g* as before from No. 3. In No. 3, draw *g* I, making the same angle with the pitch line *g k*, as *g e* makes with *g* E, in fig. 3, No. 2, draw *g* L perpendicular to HE, cutting the lower arris GF in L; make the angle K L *g* equal to the angle *e g* I, fig. 2, No. 3;

make L g equal to LK; through g draw MN, parallel to GF; then drawing the rake upon the lower side by the edge of the mould, so that the angle $e\ g$ N, on the said lower side, may be equal to the corresponding angle $e\ g$ E on the upper side; the two sides of the piece that is to form the wreath may be plumbed as before, so as to correspond with the plan when set to its position.

If it is required to draw the rake with each extremity of the concave side of the mould in the arris of the plank as in fig. 3, No. 3, it is only making the angle K L g equal to the angle $e\ g\ k$, fig. 2, No. 3; the rest is drawn, and the plumb side is formed in the same manner as No. 1 and No. 2, fig. 3, which suppose to be done, bend the corresponding part of the falling mould, fig. 2, No. 2, round the convex side of the piece for the wreath; bring the points X and J to the plane at the top, and draw the line of support at the upper extremity upon the end of the wreath; now, bring the upper end of the falling mould close to the extremity of the line of support, and draw a line by the upper edge of the falling mould; cut away the superfluous wood in the manner before described, and this will form the back or top of the rail; then gauge the two vertical surfaces to the same breadth, and cut the superfluous wood away from the under side; this portion of the rail will then be squared. The wreath for the other portion above, is identically of the same form; therefore, if two pieces are prepared by the same moulds and levels, then supposing one of these wreathed pieces to be set in its position for the lower part, and let the upper part be set in the same position, and then inverted, so that the top and bottom ends, and the upper and lower winding surfaces, will have changed places, but each of the vertical surfaces kept still upon the same side; let the lower end of the higher piece be brought to contact with the higher end of the lower piece, that the two planes may coincide and form a joint; the helical solid for half a revolution will be formed out of a straight plank as required to be done.

The two wreathed portions of a hand-rail are not always alike, as in the preceding example; this may happen in different ways, as from one quarter of the semi-circular part being divided into winders, and the other undivided, or, from the rail being placed higher upon the winders than over the flyers; but in whatever way the variation takes place, the application of the principle is the same; it only requires moulds to be constructed for every such variation, or separate part.

The intricacy of the diagrams constructed upon the Inventor's former principles, prevented their being generally understood, and very few could practise with success. But the principles here laid down, are so invariable in their result, so simple and expeditious in their application, and so easily to be comprehended, even by a moderate capacity, that they cannot fail of being introduced into general use. They unite the requisite properties of saving labour and stuff, the workman constructs his moulds with ease, and has less superfluous wood to remove. The edge of the plank is kept square, which entirely supersedes the bevelling, and is even in this point attended with a considerable saving of stuff and time, as it allows sufficient wood at the ends to make the heading joints, and as the piece which is cut out of the rail piece from the hollow side, may be turned into use; but if the edge of the plank were bevelled, it would require to be much longer, in order to form the heading joints, and the piece cut out would be too trifling to be employed to any purpose.

In addition to the advantages already enumerated, the workman will be encouraged by the clearness of the different steps of the process, which cannot fail of fully satisfying his mind as to the final result.

It is likewise a great accommodation, that any rail whatever may be cut out of the same thickness of plank,* and that the mould may be applied in any direction which the workman pleases to the surface, in order to save wood or match the fibres at the joint.

The art of forming hand-rails round circular or elliptic well-holes, without the use of a cylinder, is entirely new.

Price, the author of the "*British Carpenter*," is the first person who seems to have had any idea of this art; the subsequent writers following his schemes, which were very uncertain in their application, have added nothing to the subject, but have even thrown it into greater obscurity.

The first successful method of squaring the wreath or twist, was invented and published in the "*Carpenter's Guide*," in 1792; and certainly was the first wherein the process was subjected to any thing like geometrical principles, from which the result was attended with success. In the "*Carpenter's Guide*," (generally called simply "*The Guide*,") the formation of the face-mould was regulated by the falling mould on the developement of the rail, not by the rise and tread of the steps, as shown by Price, and his followers. When the back or upper surface of the rail had a considerable concavity, as in the

case of the junction of flyers and winders, the consequence of this regulation in many cases, in the formation of the rail, was the saving of seven or eight inches in the thickness of stuff; and thus while the method laid down by Price required a plank from six to nine or ten inches in thickness, according to the degree of concavity; that in "*the Guide*" seldom required a plank more than three inches thick, excepting in small well-holes of three or four inches in diameter.

From the great thickness of staff to cut through, and the quantity to be taken away, the time required to form the piece of wood into a wreath by Price's method, must have been at least double to that in "*the Guide*," and proportionally more so, as the thickness of the plank required by Price, was greater than that in "*the Guide*."

But though considerable advantages were thus obtained in the saving of stuff and labour, it must be observed that an elevation of the supposed vertical ends of the twisted piece at each joint, and a vertical section of the said piece, were employed to obtain the inclination of the plane of the face of the mould, or that of the faces of the plank; this inclination was only correct when the planes of the faces of the plank were at right angles with the chord plane, or that passing through the chord of the plan of the wreath; but when inclined to the chord plane, required thicker stuff, in proportion to the degree of obliquity, whether more acute or more obtuse.

The method shown in "*the Guide*," was also the first attempt to spring the plank, that is, to make its plane rest upon three parts of the rail; and though the utmost degree of perfection was not attained, it has been of great use to workmen, as all the hand-rails of stairs in and about London, and in most parts of England, have been executed upon its principles for upwards of twenty years.

To obtain still greater correctness, the Inventor tried another method, by setting up three heights, supposed to be on the surface of a curved prism, in the middle of the rail; but this, though still nearer than that published in "*the Guide*," did not give him entire satisfaction; for the resting points being in the middle of the rail, the plane of section which formed the face-mould did not clear all the three sections without cutting into the solid of the wreath.

In the pursuit of truth, he was led to consider what would be the real resting points. It readily appeared, that a level line drawn towards the axis of the well-hole, might be made to coincide in every part with the top of the rail; that if the

plane of the top of the plank be supposed to be placed on three vertical sections of the supposed rail in contact with a point in each, or coincident with the whole line of support of one of the sections, and with a point in each of the other two; and the surface of the plank thus inclined be supposed to be prolonged, to intersect the horizontal plane of the base, the intersection would always point out the resting points, and show their true seats upon the plan. From this consideration, it was evident that the resting point of each section, and consequently each seat, was that extremity of each section next to the intersecting line of the plane of the plank and that of the plan.

This theory being applied to practice, has given the utmost satisfaction, both in the saving of stuff and time; the diagram for the face-mould is completely divested of all cross and oblique lines, and is, perhaps, in the most simple form to which it can possibly be reduced; the plane of section comes in contact with the tops of three vertical sections of the rail in every case whatever, and thus every desideratum is obtained by the most simple means.

Therefore, in practice, if we suppose the section of the rail to be two and a quarter inches horizontally in breadth, and two inches in thickness (as is generally the case,) a plank of two and a half inches thick will be sufficient for a rail, with any degree of concavity or convexity on the back.

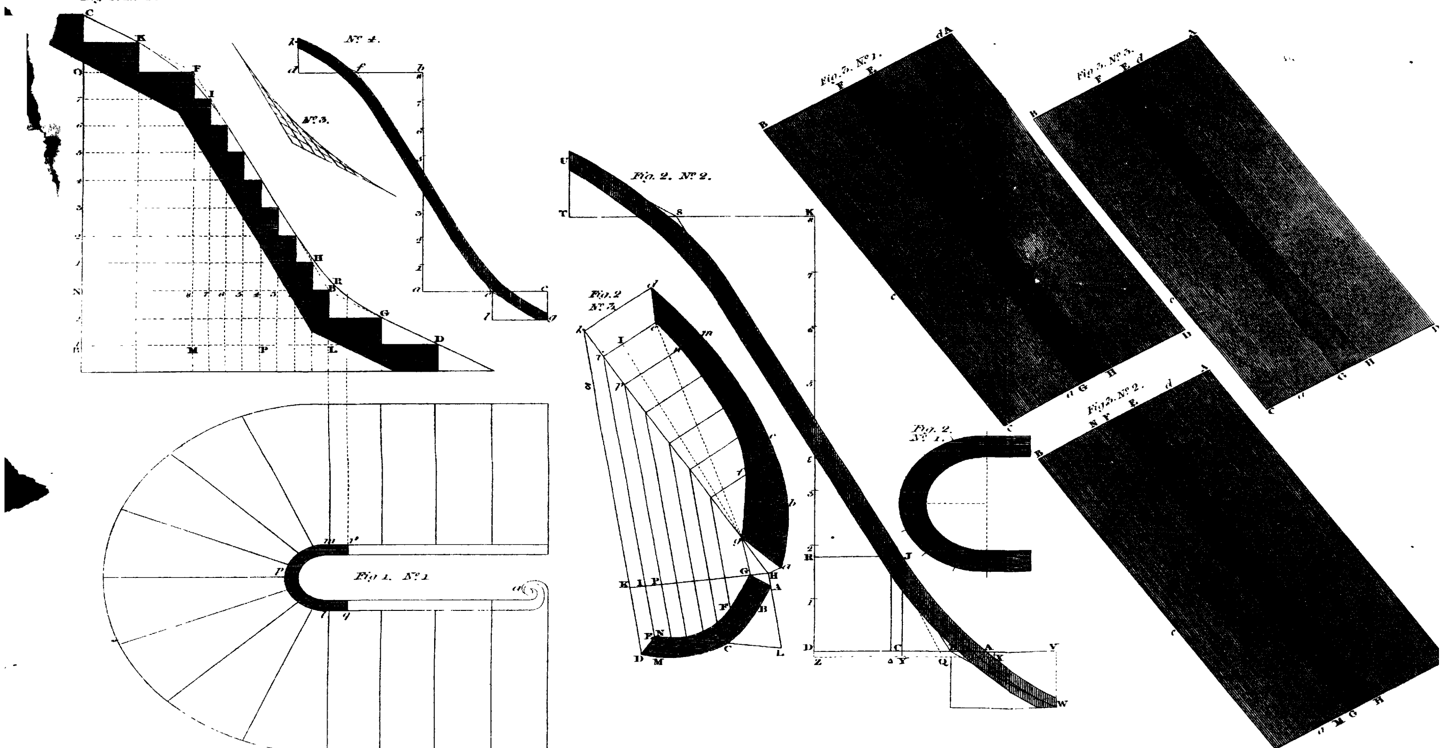
We shall now proceed to the illustration of the subject by figures which represent the solids themselves:—

Fig. 1, plate LXXIII, is a plan of the cylinder, with the elevation of the helical line, which is found by dividing the height into equal parts, and the circumference of the base into equal parts also, then drawing the lines through the points of division, as in the figure.

Fig. 2, a representation of the solid helix twisting round the cylinder, making a continued rail upon a circular plan; the curvature of the solid helix is, therefore, everywhere the same. The rail is exhibited as squared; and though it appears as one piece, it must be understood to consist of several wreaths, or lengths, screwed together, each length answering to a quadrantal part of the plan.

Fig. 3, shows the different sections of a hollow cylinder, cut entirely through the curved surface; the solids exhibit a portion of the said cylinder contained between two parallel planes: No. 1, shows the thickness of the section according to the inclination of the cutting plane; No. 2, shows the section of a semi-cylinder; and No. 3, that of an entire cylinder, cut

Nicholson's Mode of squaring Hand-rails.



Published by Henry Fisher Caxton, London 1823

Nicholson's Method of squaring Hand rails.

Fig. 1.

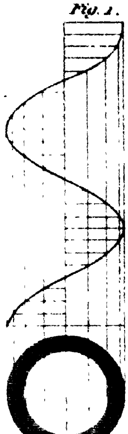


Fig. 2.



Fig. 3.

Nº 3. Nº 2. Nº 1.

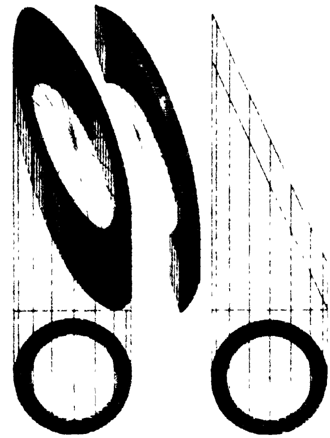


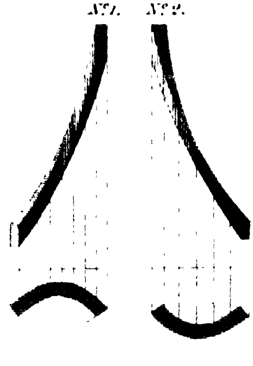
Fig. 4

Nº 1 Nº 2



Fig. 5.

Nº 1. Nº 2.



according to the position of No. 1; the sections No. 2, and No. 3, being turned round, so that the plane of section may be brought into view, in order to make the solid appear.

Fig. 4, exhibits a solid section of a hollow cylinder, upon a quadrantal plan, with a small part straight; No. 1, exhibits the convex side, No. 2, the concave side. This figure shows the state of the rail-piece, as prepared by the face-mould, and is therefore bounded by two concentric cylindrical surfaces, and two parallel planes. The falling mould being applied upon the convex side, the superfluous wood is cut away according to a line drawn by the upper edge of the falling mould, in such a manner that the stock of the square, being applied upon the convex side, parallel to the axis, the under edge of the blade may coincide with the top or winding surface of the rail-piece. The thickness of the rail is regulated by running the stem of a gauge first upon the convex side, with the head upon the top or winding surface, and then the stem upon the concave side in the same manner, and cutting away the superfluous stuff between the two gauge lines.

Fig. 5, exhibits the wreath, or rail-piece, as completely squared: No. 1, shows the concave side, with the lower end of the back, or upper surface, and the higher end of the lower surface; and No. 2, the convex side of the cylindric surface, with the upper part of the back, and the lower part of the under side.

The rail exhibited in fig. 2. is only a succession of wreaths, as in fig. 5.

From what has been shown, it will be easy to conceive how a rail may be executed to any given plan, and to any developement of the steps according to that plan.

Though it may be possible to make a rail in one piece, as in fig. 3, No. 3, such a rail will hardly ever come into practice; the representations of the solid sections, in Nos. 2 and 3, are therefore not shown with a view of being prepared for a rail, but to give a clear view of the different parts of the solid sections of a hollow cylinder.

Improved Method of Bending Timber, for building large Ships.

The following machinery for bending the timber of large vessels, is calculated to afford excellent floor timbers, futtocks, breast-hooks, long riders, beams, knees, &c.

The constant want of compass timber, and the difficulty of obtaining it, is apparent, and seems to increase every year. The consequence is manifest to all persons who have knowledge of ship-building, and requires no comment.

The method proposed, has not only the effect of lessening the consumption of timber, but of adding strength to that which is used, as the timber can be worked much longer without being cut across the grain, which is frequently the case, and indeed unavoidable in the usual mode of moulding ship-timbers.

In the building of a seventy-four gun ship on the present plan, a saving will be made of about fifteen hundred pounds and a general saving to the country of fifty thousand pounds per annum, in ship and boat building; and this is not the only advantage, the plan will give a constant supply of timber, which cannot otherwise be obtained.

The plan has been tried, and found to answer every end intended, and is likely to become a general benefit to the United Kingdom.

The Inventor of the machinery has been a servant to the public 38 years, and has for some years made it his study to accomplish this purpose; and he is confident the saving will be immense, and the ships and boats much stronger.

On May 2nd, 1813, he bent the largest piece of timber that ever was bent in England, to a four-feet eight inch curve in thirty feet long, sixteen inches square, for a floor-timber for the Black Prince, of seventy-four guns, in eight minutes' time. This was a saving of twelve pounds sterling in one floor-timber. Many persons thought it impossible to perform such an operation till they saw it accomplished.

Before the invention of this machinery, recourse has been had of late years, to make the curves out of two or three pieces, which of course consumed more timber, and required a considerable expense in workmanship.

The method has been repeatedly tried in the Royal Dock Yard at Woolwich, and its utility fully proved. The floor-

timbers for the Black Prince, of seventy-four guns, have been bent as above stated; and a breast hook for the Nelson, a first-rate man of war, which is bolted between the upper and middle deck, made out of English oak, also long timbers in a serpentine form.

With respect to oak timber, the Inventor of this machinery has learnt from experience, that Sussex oak is the best in the world for elasticity and durability. That which grows on the south-west parts of Kent, and north-east part of Hampshire, is next in quality. Previously to the timber being steamed and bent, a horizontal cut is made with a saw, which answers two purposes; it gives ease in the operation of bending; and when the two parts are bolted together, the return of the timber to its former shape is more prevented. It also removes the gore piece at the butt end, when it is shaken or defective, which is frequently the case. After the operation, the inner curved part will be found rather longer than the outer one, and forms an useful abutment in fixing the timber at its end.

Fig. 1, plate LXXIV, is a side view of the machine, on a scale of $\frac{1}{72}$d part of the real size, as adapted for bending midship floor-timbers, which have previously been either boiled or steamed.

The machine is divided in the middle at *a*, so as to alter its length for different sized timbers, and is kept apart, to the required length, by the suitable notches of the adjusting blocks *b* and *c*, the pressure against these being very great; hooks, one of which is shown at *d*, are fixed upon each side of the front or moveable half, to catch in holes or rings in the floor, to assist in retaining it: the other half is firmly fixed. On the adjusting blocks are placed two opposite wedges *c* and *e*, similar to those used in shoring up ships, in Sepping's mode, (see page 168,) to support the middle of the timber; on the next blocks are iron rings, with a wooden bar through them, to keep down the timber; but screws, as *h h*, are generally preferred: *g g*, *i i i i*, are uprights for the windlass or capstan *k*, which may be put in that part which best suits the timber, and when brought down by the action of the levers, the timber is secured by the screw press *h*; *b b* are iron bolts to keep the windlass down, as soon as the timber is bent.

Fig. 2 is an end view, to show the combined action of the two windlasses and blocks. Iron plates, *m m*, are laid on the timber, to prevent the grain from rising, the ends of which are thickened with heads, *n*, fig. 3, to keep the ropes from slipping off; the ropes are united by a double hook or open

link *o*, fig. 3, and then passing through the blocks *t t*, fig. 3, (which are also attached to the floor by their ropes going once under the middle timber *p*, and then lashed together by a smaller rope,) are twice wrapped round the first windlass *k*, figs. 1 and 2, and passing again through the blocks, are fastened to the second windlass *v*; by this means a great pressure is obtained. Fig. 4 shows the manner of fastening the bolts of the screws *h* to the blocks, the holes are widened like the Roman letter V, to let the screws accord with the bend of the timber, and to suit different sized timbers; the bolts *q* have two or more loop-holes at the bottom, to pin the convex nut *s* on; this nut rolls in a less concave iron plate *r*, let into the bottom of the block. Under the upper wooden bar of the screw-press is a plate of iron, having a socket screw in which the screw works, and its point pressing against a band of iron which encircles the lower bar, forces them asunder in action.

The machine is built upon three floor-timbers, the middle one *p*, fig. 3, is thinner than the other two, to let the block ropes pass under.

Fig. 5 is the plan to make eight midship launches, to be framed out of one piece.

Plate LXXV, fig. 1, is another construction of the machine for bending differently shaped timbers, in which the alteration is made by the disposition of the chocks or cross-blocks.

Fig. 2 is a floor-timber of a 74-gun ship of one piece.

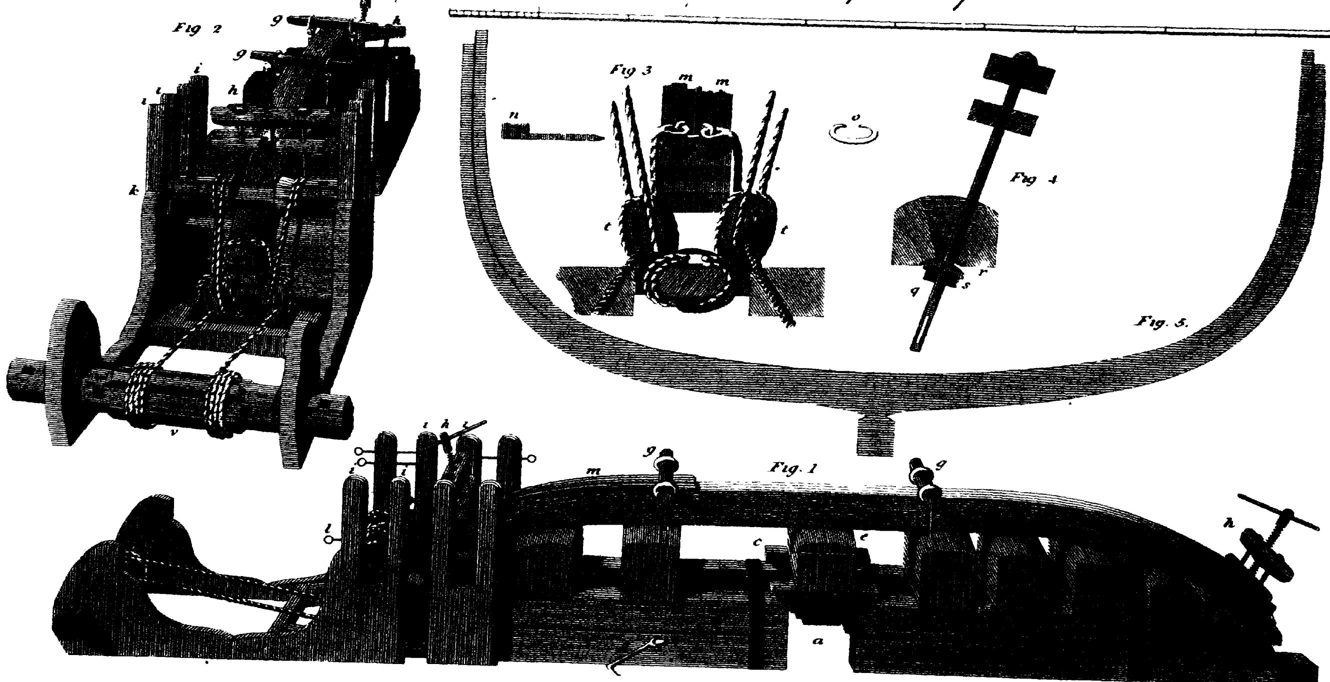
Fig. 3, a breast-hook of one piece.

Fig. 4, a top timber, similar to that in the machine.

The timber is first sawn down the middle, as far as it is to be bent, as shown by the line *a*, in the different timbers, which greatly increases the power of bending it, and permits the one part to slide over the other, so as to lessen the tear of the different parts; which are afterwards secured together by bolts passed through them, and may be still farther stiffened, by the additional pieces let into them, as shown at figs. 2 and 3.

Fig. 1, being on a larger scale, affords an opportunity of showing the handspikes or levers placed in the holes of the windlasses or capstans, by the joint action of which the timbers are forced into the requisite curves; to suit which the blocks must be previously arranged, as well as the beams which support them, and which are so managed, as to form buttresses to prevent the blocks from shifting their places, in the act of bending the timber; and the whole is securely united together by iron bands, &c.

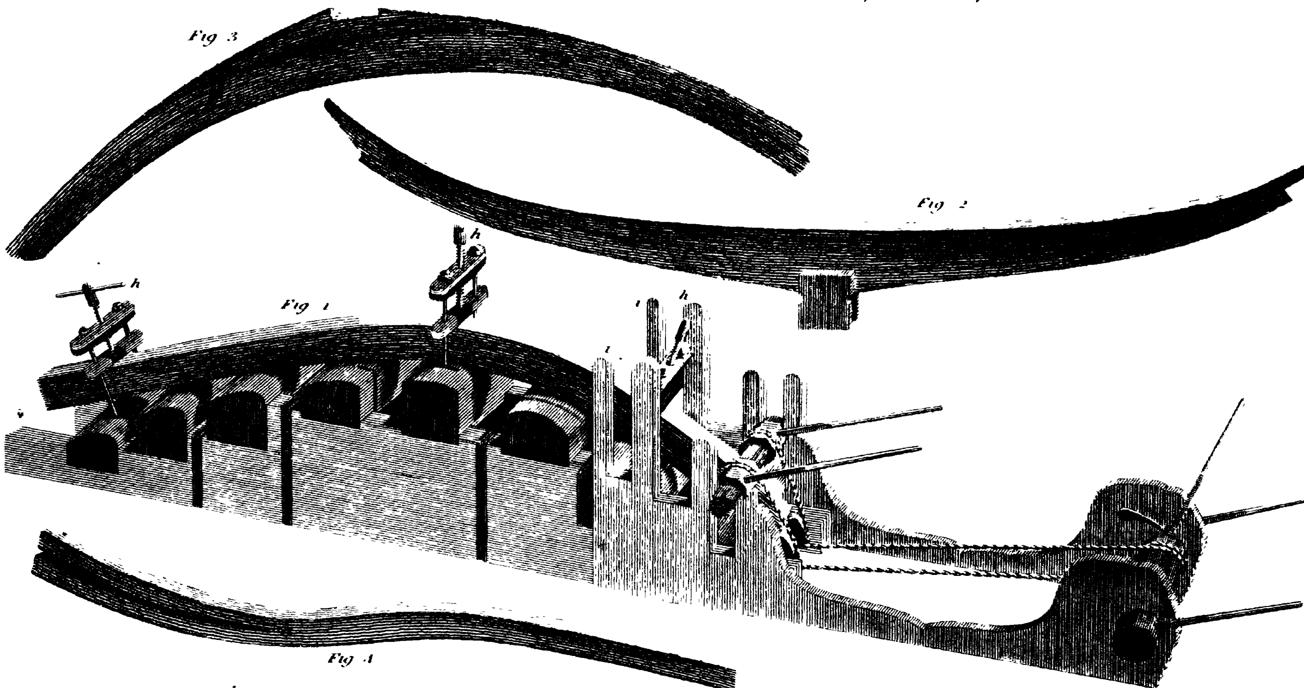
Hookey's method of bending Timber for Ships.



T Wallis sc

Publish'd by Henry Fisher, Caxton, Liverpool. Nov. 1818.

Hookey's method of bending Timber for Ships



T Walis sc

Published by Henry Fisher

A Machine for braking, hackling, and scutching Hemp.

The horizontal wheel of this machine is 12 feet diameter, the shaft 10 feet long. Upon the top of the rim of the said wheel, should be 24 cogs or pins about 1½ inch thick, at equal distances round the circle, which act upon the levers that raise the brakes. From these levers are extended small bars fastened to a roller near the centre of the brakes, which brakes should be made of plank, 1 foot wide, and 2 inches thick. The planks which form the under part of the brakes, are three feet long, and are fastened to a piece of timber at the bottom 8 feet long, 18 inches wide, and 8 inches thick.

The jaws of the brakes rise 45 degrees, so as to form a right angle. From each of these planks are framed (across) the blades or beaters, which intersect each other, and brake the flax or hemp. The lower end of the upper part of the brake plays on a pin running through the timber, and on this timber is fastened a spring with the upper end bearing upon a roller which passes through the side plank of the upper jaw, in order to force the brake down. This spring is so fixed as to be strengthened or weakened at pleasure by a key. There should be two brakes, one on each side of the wheel, which if the machinery is worked by a horse wheel, should be placed two feet above the level of the horses' feet.

The scutching part is a wheel, two feet long, and 3½ feet diameter, in the rim of which is placed 6 blades, which serve as wooden knives against a moving rack to clean the hemp or flax. This wheel should be vertical, and the knives horizontal. Upon the axis of this wheel, at the end, is a groove or pulley, 8 inches diameter, and a band running about it, also around a band-wheel under the large wheel, formed by hooked pins, extending downwards from the arms of the large wheel.

The operation of dressing hemp or flax, to separate them from the woody stalk of the plant into distinct fibres, which will admit of being spun into ropes or thread, is generally performed by means of the brake and scutcher, which are worked by hand.—The hand brake is a machine which was for many ages chiefly employed in braking and separating the *boon* from the flax, which is the cuticle or bark of the plank; it is a plank supported on legs like a stool, and another placed

upon it, being united to the former at one end by a centre pin, and the other having two teeth called swords, fixed upon it across its breadth, which interlock in the space between three similar teeth fixed across the lower plank.—In using this machine, the flax being held in the left hand across the three under teeth or swords of the brake, the upper teeth or swords are then with the right hand quickly and often forced down upon the flax, which is artfully shifted and turned with the left hand, in order that it may be fully and completely broken in its whole length.—The flax stock and scutcher are implements for braking, cleaning, and scutching flax, in the old method of dressing it. The stock is a plank fixed like a bench before the workman, and the scutcher is a kind of short wooden sword, with which he strikes the flax, while it is hanging over the edge of the stock. In this business, the workman, with his left hand, holds the flax over the stock, while with his right hand he strikes the flax with the scutcher, with a sloping stroke.

This method of braking and scutching flax by hand being extremely tedious and laborious, the mill was invented in Scotland many years ago, but has been lately much improved, and being driven by water, it makes great despatch, and in skilful and careful hands generally gives satisfaction. It has been generally constructed so as to break the boon by three indented rollers, placed one above the other, the middle one of which being forced quickly round, takes the other two along with it, and one end of the handfuls of the flax being by the workmen directed in between the upper and middle rollers, a curved board or plate of tin behind the rollers directs the flax to turn in again between the middle and undermost rollers; and thus the operation is repeated until the boon be sufficiently broken; great weights of timber and stone, placed at the ends of levers, are also employed to press the upper and under rollers towards the middle one.

The business of scutching is carried on by the mill, in the following manner: four arms, something like the hand scutchers before described, project from a perpendicular axle; a box placed around the axle incloses these projecting scutchers, and this box is divided among the workmen, each having sufficient room to stand and handle his flax; slits are made in the upper part and sides of the box, and through them they hold the flax against the stroke of the scutchers, which moving round horizontally, strike the flax across, at right angles, and so thrash out, or clear it of the boon.

Durand's machine for braking, hackling, and scutching hemp.

The braking of the flax by rollers is scarcely subject to any objection, except that it is dangerous to workmen not sufficiently on their guard, who sometimes allow the rollers to take hold of their fingers, and thereby endanger their whole arm being instantly drawn in; and this way many have lost their arms. To avoid this danger, a brake, upon the general principles of the hand-brake before described, has been lately adapted to water machinery, and used in place of rollers with great advantage.

The horizontal stroke of the scutcher was long thought too severe, and wasteful of the flax; but very careful experiments have discovered, that the waste complained of must be charged to the unskilfulness or negligence of the workmen; as, in good hands, the mill carries away nothing but what, if not so scutched off, must be taken off in the hackling with more loss, both of time and flax; but to obviate the objection of the violence of the horizontal scutchers, an imitation of hand scutching has been applied to water. The scutchers there project from a horizontal axle, and move like the arms of a check-reel, striking the flax neither across nor perpendicularly down, but sloping in upon the parcel exactly as the flax is struck by the hand scutcher; this sloping stroke is obtained by raising the scutching stock some inches higher than the centre of the axle, and by raising or lowering the stock over which the flax is held, or by screwing it nearer to, or farther from the scutcher, the workman can temper or humour the stroke almost as he pleases.

Upon the latter principle, the present machine is constructed in combination with brakes, like the hand-brake, but worked by machinery; the whole is made in an economical manner, chiefly of wood, so as to be fit for the country use in Canada, where the culture of hemp is attended with very great advantage.

Fig. 1, plate LXXVI, is a perspective view of the whole machine: and fig. 2, is an elevation of one of the brakes separately, and on a larger scale.

The machine may be worked either by the power of horses, or by a water-wheel; in the former case, the levers by which the horses draw, may be fixed to the vertical shaft A, and they will walk round beneath the wheel B; but in situations where a fall of water can be obtained, its power is applied in the manner represented in the plate. The water-wheel is supposed to be placed behind the wall CC, and its axis comes through an aperture in it, having the crown-wheel D fixed upon it; the teeth of this act upon a trundle, fixed upon the vertical axis A, and thus gives it motion; the wheel B has pins or cogs fixed upon it, which act upon the short levers *a*, *b*, and these, by

means of rods *d d*, communicate motion to the two brakes F and G; these are upon the same construction as the hand-brakes before mentioned, though rather differing in their position; a thick plank of wood *c* is fixed down upon the floor, and at one end the two pieces *l l*, are erected in an inclined position, and support the two fixed swords or teeth *e*, as shown in fig. 2; *f* are the moving teeth fixed to two pieces *g h*, which are attached to the plank by a centre pin through the end *h*; a pin is extended across between these two, and passes through the end of the rod *d d*, and another similar pin is extended between them, rather nearer the centre; upon this the spring *i* operates to throw down the upper teeth of the brake upon the lower: when the ends of the levers at *a* and *b* escape from the cogs of the wheel B in its revolution, the flax being held between the teeth, is by repeated blows broken in the manner before described; the succeeding cog of the wheel B, raising up the brake again as soon as it has fallen, by one cog passing by; as the two sides of the wheel B move in opposite directions, the levers *a* and *b* are differently constructed, the cutter operating on opposite sides of the centre of motion; thus the cog of the wheel acts upon one end, and the rod *d* is jointed to the other. The lever *a* has the rod *d* connected with it very near the same point as that where the cogs of the wheel meet it. The scutchers are marked H and I; they are framed of four arms, projecting from a horizontal axis, mounted on pivots which are supported by vertical standards, as plainly shown: the end of these arms carry pieces of wood, which are properly shaped for scutching the flax over the edge of a stock, fixed near them for that purpose, and adjustable as before described; the two scutchers H and I, revolve in opposite directions to each other, and their stocks are therefore placed on opposite sides; that which supports the flax which is to be operated upon by the scutcher, I, being placed before it in front, but the stock for the other H is behind; by this means the two workmen do not interfere with each other. These opposite motions of the scutchers are given by two endless bands from a drum or cylinder K, situated over them; one of these bands is crossed and the other not, therefore they communicate opposite motions to the two scutchers. The cylinder is put in motion by means of an endless band *h*, running in a deep groove in it, which crosses, and is then carried round a circle of cleats or riggers, with angular notches in them, to receive the band fixed to the wheel B beneath it; thus by the same motion of the mill, the two stocks and two scutchers are both actuated, and by the simplest machinery.

Method of preventing Annoyance from the Steam of Boilers.

The object of this invention, which is in numerous cases so extremely desirable, is accomplished by a contrivance of great simplicity. The Inventor having finished a new building, for the whitening and stoving of woollen cloths, and having, in his old premises, been much annoyed by the steam from the hot water in the pans, as well as having had ample proof how injurious steam was to the timber of the floors, &c. he determined to obviate similar effects for the future by removing the cause. After many ineffectual experiments, he found the expedient proposed in this article to answer his most sanguine expectations.

AA, fig. 3, plate LXXVI, the brickwork surrounding the pan.

B, the steam chimney, made of wood, about two feet broad and six inches deep. A small opening at the back part of the pan admits the steam into this chimney; it may from thence be carried up to the top of the building, or turned into any smoke chimney near at hand.

In order to keep the water in the pan as hot as possible, during the night, there are two dampers in the steam chimney at D, and if both these dampers are shut, and the whole top of the pan covered closely over at C, the boiling water, even when the fire is withdrawn, will keep hot for the workmen till the next morning.

CC, are loose boards, fitting close to each other, and covering completely above half of the circle of the top of the pan; and upon this circumstance depends the whole secret of getting quit of the steam. If you remove these boards or partial coverings, the steam chimney loses all its use. The letter *b* shows the part of the top of the pan which should be left open to admit to the workmen a ready communication with the hot water, and through this open part a current of cold air is constantly seen to press and force the steam rapidly up the steam chimney.

It is proper to add, that there must always be an empty space of two or three inches between the surface of the hot water and the under part of the cover CC, so as to permit the steam to pass the bottom of the steam chimney. To effect this

purpose, and at the same time to allow the copper to be full of hot water, a rim or curb of wood F, about three inches thick, should be fixed upon the top of the copper, and upon this the covering boards CC placed; this allows sufficient room for the steam to press forward to the steam chimney at all times.

The cover and wooden steam chimney are removeable, and may serve for another copper, if both are not wanted at the same time.

This easy method of carrying away steam, if once known, will be of very considerable utility. In the numerous instances where steam is inconvenient, it offers a ready riddance; to the timber in buildings, and to the furniture in houses; private kitchens, &c. it affords a desired security; but in many trades, as glue-makers, tallow-chandlers, &c. where the effluvia, united with or without water, is offensive and obnoxious, it must be doubly and trebly valuable; and these cases are very numerous. Evaporating matter need no longer be the torment of workmen, or the nuisance of the neighbourhood.

It is not absolutely necessary that the steam chimney should be carried up as high as the smoke chimney. It has been proved by experiment, that if the steam enter the smoke flue only six feet above the top of the pan, the beneficial effects of the invention will be fully secured.

Steam flues on this plan may be advantageously adopted not only in kitchens, but in wash-houses and brew-houses; they may be variously curved, as the case requires, to reach the most convenient smoke chimney. It is advisable, at the lower part of the aperture, where the steam enters a smoke flue, to place a stone, so as to project a little way into the chimney, in order to break the current of the ascending smoke, and thereby facilitate the entrance of the steam. In some cases, also, a curved form may be found the most eligible for the steam chimney, in order to prevent a gust of wind, or any other casualty, from forcing soot down into the liquid in the pan.

END OF THE FIRST VOLUME.

Printed by H. Fisher, at the Caxton Press, London.